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State University of New York College of Environmental Science and Forestry

ANNOUNCEMENT
OF COURSES

GRADUATE AND
UNDERGRADUATE

STATE UNIVERSITY
OF NEW YORK
COLLEGE OF FORESTRY

Vol. 8A

1974-75
TO
1978-79

BIOCHEMISTRY • BIOLOGY • CHEMICAL ECOLOGY • BIOMETRY • BOTANY • BUILDING CONSTRUCTION • CHEMISTRY • CELLULAR ULTRASTRUCTURE • ECOLOGY • ENVIRONMENTAL STUDIES • ECONOMICS • ENGINEERING • FOREST TECHNOLOGY • FIBER PHYSICS • ENTOMOLOGY • LAND USE • LANDSCAPE ARCHITECTURE • LIMNOLOGY • PAPER SCIENCE • MATERIALS MARKETING • METEOROLOGY • PAPER ENGINEERING • MICROSCOPY • MYCOLOGY • SOILS • REGIONAL PLANNING • NATURAL PRODUCTS ENGINEERING • OPERATIONS RESEARCH • ORGANIC MATERIALS SCIENCE • WATER RESOURCES • RESOURCE POLICY • PATHOLOGY • PHYSIOLOGY • POLYMER CHEMISTRY • PHOTOGRAMMETRY • PRODUCTION SYSTEMS ENGINEERING • OUTDOOR RECREATION • REMOTE SENSING • RESOURCE MANAGEMENT • SILVICULTURE • URBAN ANALYSIS • THERMODYNAMICS • WILDLIFE • WOOD PRODUCTS ENGINEERING • ZOOLOGY • WORLD FORESTRY • PATHOLOGY • WOOD SCIENCE • LAND USE • METEOROLOGY

GRADUATE STUDIES

STATE UNIVERSITY OF NEW YORK — COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

CORRESPONDENCE DIRECTORY

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State University of New York

COLLEGE OF

ENVIRONMENTAL SCIENCE AND FORESTRY

1974-75

Graduate Studies Bulletin

TABLE OF CONTENTS

	Page
Academic Calendar	2
Graduate Study at ESF	3
Requirements for Degrees	5
Admission	7
Expenses	9
Financial Assistance	11
Graduate Degree Programs	15
Multidisciplinary Programs	15
Disciplinary Degree Programs	18
Course Offerings	41
Index	Cover 3

ACADEMIC CALENDAR

Fall 1974

Residences Open, New Students	September 1	Sunday, 8 a.m.
Orientation Begins	September 2	Monday
Counseling Begins	September 3	Tuesday
Registration	September 4–6	Wednesday–Friday, 8 a.m.
Classes Begin	September 9	Monday, 8:30 a.m.
Yom Kippur	September 26	Thursday, no classes
Last Day To Drop/Add	September 27	Friday
Mid-semester	October 3	Thursday
College Barbecue Day	October 9	Wednesday, no classes
Fall Recess	November 27–December 2	Wednesday, 12 noon–Monday, 8:30 a.m.
Last Day of Classes	December 12	Thursday, 11:00 p.m.
Reading Period	December 14–15	Saturday–Sunday
Examinations	December 13–20	Friday–Friday
Vacation Begins	December 21	Saturday

Spring 1975

Registration	January 14–16	Tuesday–Thursday
Classes Begin	January 17	Friday, 8:30 a.m.
Last Day To Drop/Add	February 6	Thursday
Mid-semester	March 7	Friday
Mid-semester Vacation	March 8–16	Saturday–Sunday
Last Day of Classes	April 25	Friday
Reading Period	April 28–29	Monday–Tuesday
Examinations	April 30–May 7	Wednesday–Wednesday
Commencement	May 10	Saturday

1975 Summer Sessions at Syracuse University

First Session	May 19–June 27	Six weeks
Second Session	June 30–August 8	Six weeks

Graduate Study at ESF

Society is increasingly in the hands of those who have broad foresight and reasoned judgment in applying sociological and technical knowledge to guide human and environmental forces. Modern civilization—with its compelling demands from industry, government and educational institutions—requires persons who think objectively and constructively, and who act creatively and responsibly.

A purpose of the graduate years is to develop these persons. These years are a time of discovery and excitement, a time of answers and new insights, a time of personal productivity and contributions to scholarship. It is during the graduate education that the student develops the ability to think critically and analytically, to plan research, to design experiments, to work effectively with the basic research tools as well as specialized equipment, and to undertake the discipline of purposeful study toward a specific goal.

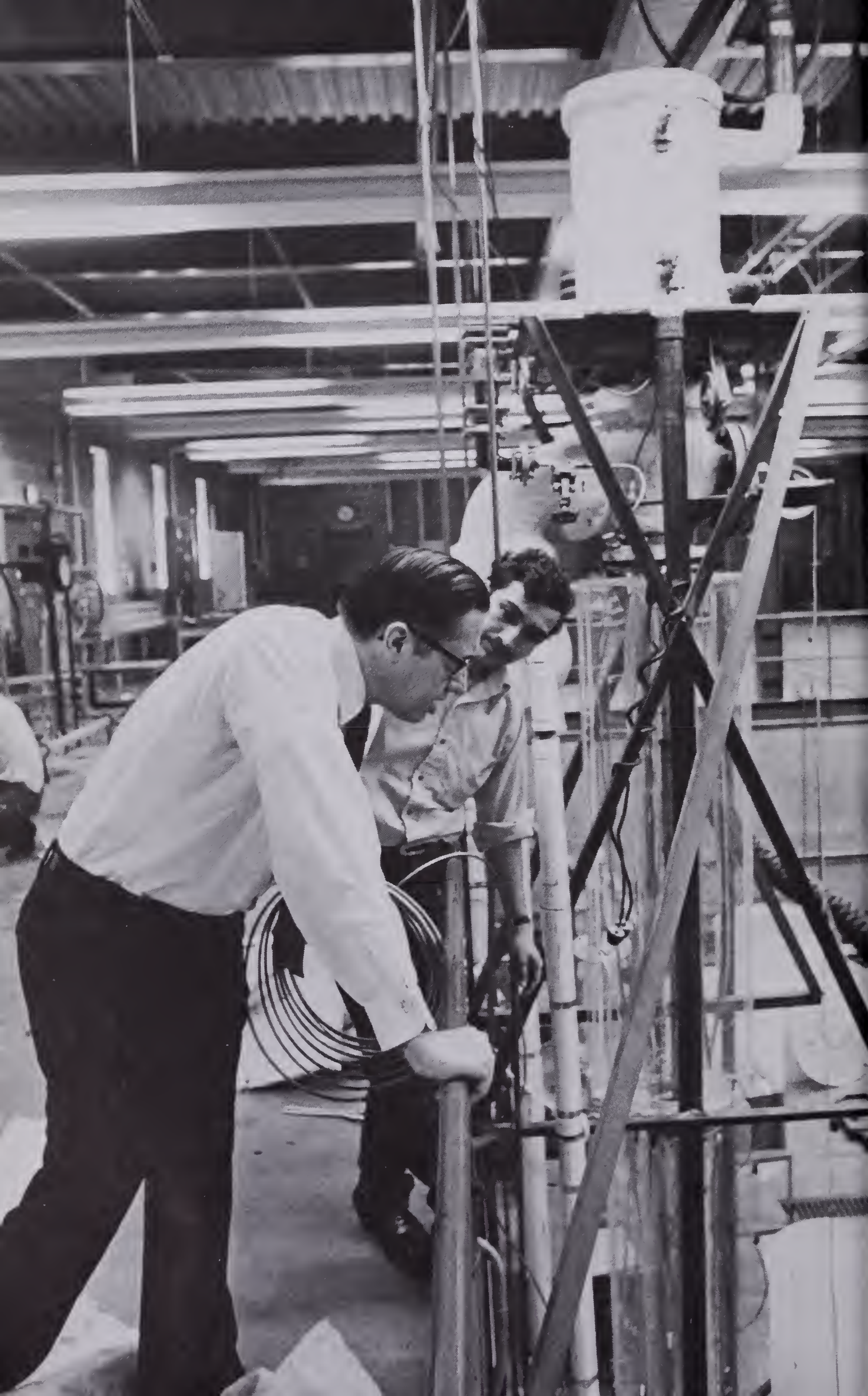
From its beginnings in 1911, the State University of New York College of Environmental Science and Forestry has served New York State and the nation in meeting the needs of its citizens in regard to the environment through education, research and public service. The faculty and students of the institution are committed to the resolution of immediate environmental problems, the development of the knowledge necessary to predict occurrences in the future, and the presentation of public policy alternatives that will both protect the environment and accommodate the real needs of society.

The major impetus for this inquiry lies in the research programs of the College in which the graduate students play an integral role with the faculty. The College has more than 150 faculty whose research interests in various aspects of environmental science involve more than 300 graduate students in master and doctoral degree programs.

The College currently supports significant graduate degree programs in eleven disciplinary subject areas and in addition, its broad program in environmental science encourages the development of multidisciplinary graduate research in more than ten study areas.

The diversity and depth of the graduate programs of the College reflect the work of its excellent faculty and their graduate student colleagues utilizing some of the most modern facilities and laboratories in the country. They maintain a long-standing tradition of academic and professional excellence.

This bulletin provides an introduction to the College and its programs of graduate study and research. It only begins to suggest the diversity and depth of the existing and potential programs that make environmental science the *challenge of the 70's.*



Requirements for Degrees

Graduate programs are flexible and developed individually. Each program is planned by the major professor with the student to meet the individual's particular academic and professional needs. Sometimes this includes undergraduate courses for which no graduate credit can be given. In every case, emphasis is placed on outlining a study program leading to a high level of scholarly achievement.

An entire program for each student is planned and must be approved by the major professor, department chairman and School Dean. The program is modified as required upon recommendation of the major professor. A thesis committee composed of the major professor and two other faculty members is appointed early in each student's study program. In some departments, all graduate students are required to engage in an appropriate teaching assignment as an academic degree requirement.

THE MASTER'S DEGREE

All programs leading to the Master of Science (MS), Master of Forestry (MF) and Master of Landscape Architecture (MLA) degrees require at least 30 semester hours of graduate credit and two semesters in residence. From 6 to 18 hours of graduate credit may be earned through completion of a thesis or special project. The remaining credit hours are earned through completion of course work. A total of at least 15 hours of credit, including thesis and special project credits, must be in courses numbered at the 600 level or above.

Acceptance of the thesis or special project depends on clear demonstration of ability to search and evaluate pertinent literature independently, to plan and carry through independent and important investigation, to interpret the significance of findings, and to present the subject in a well-organized, lucid and scholarly thesis. The student must also pass a final oral examination in thesis defense and demonstration of knowledge or related subject areas.

THE DOCTORAL DEGREE

Quality of work is especially emphasized for the doctor of philosophy degree. The student is required to penetrate the frontier of knowledge in the particular field of study and make a definite contribution to this knowledge. The student is also required to demonstrate original scholarship of a high order in the search and evaluation of literature, in the planning, execution and interpretation of scholarly research, and in the presentation of the findings in a thesis. Subsequent publication in a scholarly journal is expected.

There is no minimum credit hour requirement for the Ph.D. Each student must pass a qualifying examination before being admitted to candidacy. This two-part examination consists of a preliminary examination taken early in the period or residence to assist in planning a course work and independent study program, and a written and oral comprehensive examination to test breadth and depth of knowledge. There is no College-wide language requirement. However, competence in a foreign language, statistics, computer programming or other "tools" may be required where they are relevant to the student's field of study. A candidate for the Ph.D. degree with only a bachelor degree must be in residence for at least two full academic years. A candidate having a master's degree must be in residence for at least one full academic year. The final requirement is the presentation and defense of the Ph.D. thesis or dissertation which must represent an original contribution to knowledge.

Admission

REQUIREMENTS

Admission to graduate study may be granted only to applicants with at least a bachelor's degree from a recognized institution, whose preparation has been suitable in quality and content for the proposed field of major study. Applicants will be evaluated on the basis of the following: (1) their academic record should show at least a "B" or 80 percent average for the junior and senior years; (2) Graduate Record Examination Aptitude scores, and, in some cases, subject matter (advanced) tests indicative of graduate study ability; (3) supporting letters of recommendation; (4) a statement of specific educational and professional goals which describes the choice of degree program and the students' plan for the pursuit of the objectives in the program; and (5) where appropriate, other evidence of scholarly achievement and potential. Admission is selective with priority given to applicants who have high scholastic standing.

PROCEDURE

All applicants are required to submit Graduate Record Examination aptitude scores. This examination is offered several times each year in major cities of the world. For information on registration and scheduling write to the Educational Testing Service, Princeton, New Jersey 08540. Test scores should be sent to the Office of Graduate and Instructional Affairs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210 (Institutional number R2530).

The College provides a special form for application for graduate work. Requests for information and applications should be addressed to the Office of Graduate and Instructional Affairs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

INTERNATIONAL STUDENTS

Citizens of other countries with special educational objectives are accepted for graduate study in all programs. They must show satisfactory evidence that they have completed studies in their major field equivalent to those at a recognized American institution with a scholastic record equivalent to a B average in their junior and senior years. They must submit Graduate Record Examination scores as explained in the section on Admission Requirements. Also, applicants whose native language is other than English must submit scores on the Test of English as a Foreign Language (TOEFL). This requirement may be waived if the student has received a degree from an American institution. This examination is offered several times each year in major cities of the world. For information on registration and scheduling write to the Educational Testing Service, Princeton, New Jersey 08540, U. S. A. In submitting test scores, request that they be sent to the Office of Graduate and Instructional Affairs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

Expenses

TUITION AND FEES

The tuition and fee structure at the College includes library, health, infirmary, physical education, special testing and other services, as well as an assessment for student activities and charges for expendable supplies and equipment.

Graduate tuition for New York State residents is $600 per semester. Nonresident tuition is $750 per semester. All graduate students pay an activity fee of approximately $25 per year.

COMMENCEMENT FEE

Candidates for a master's degree pay a commencement fee of $25. Doctoral candidates pay $50.

HOUSING

The College does not operate student residences. These facilities are offered by Syracuse University. Furnished and unfurnished apartments for single graduate students and for married graduate students and their families are located on the South Campus, approximately two miles from the Main Campus, and are serviced by a regular shuttle-bus.

Any student who wishes to live in Syracuse University housing should write to the Director, Married Students' Housing, 1528 East Colvin Street, Syracuse, New York 13210. Formal admission to graduate study is required before such requests are granted.

In addition, a wide variety of living arrangements in private homes and apartment complexes is available in the metropolitan Syracuse area.

OTHER COSTS

All graduate students are required to have health and accident insurance. Graduate fellows funded through the State University Research Foundation are required to take the health and accident insurance available through the Foundation.

The costs of textbooks and supplies may average $125 or more a year.

Financial Assistance

The College awards a substantial number of assistantships, fellowships and scholarships to qualified graduate students each year. The number of students receiving these awards varies from year to year, but usually more than half of all graduate students have received such support. In many cases it is not possible to provide a stipend at the start of the graduate study period, but such support is often provided after the student has demonstrated his competence.

Students may indicate their interest in a type of financial assistance on the last page of the graduate application form. Students on fellowships or assistantships must devote full-time to graduate study. Students seeking financial assistance should be sure their application and supporting documents reach the Office of Graduate and Instructional Affairs before March 1, to ensure full consideration for an award for the fall semester.

GRADUATE ASSISTANTSHIPS

Assistantships are awarded to students of demonstrated scholarship and whose education and experience enables them to assist in laboratory instruction and research. The amount of the assistantships is approximately $3,400 per year. In addition, tuition may be waived. Students on assistantships must carry 12 credit hours of course work, including research, per semester.

SPECIAL FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships and assistantships sponsored by industries, associations and foundations are available in several departments. The amount of stipends varies. Holders of these special fellowships and assistantships are required to confine the major part of their research activities to specified fields. Tuition usually is either waived or provided by sponsors.

TUITION WAIVER SCHOLARSHIPS FOR INTERNATIONAL STUDENTS

Tuition waivers may be awarded to a limited number of international students judged to possess special academic capabilities and with demonstrated financial need, who are prepared to contribute to furthering international understanding and good will. Requests for such tuition waivers may be made on the last page of the graduate application forms.

SCHOLAR INCENTIVE PROGRAM

Qualified New York State residents are eligible for Scholar Incentive Program grants and State University Grants-in-Aid which vary with the net taxable family income of students, and the level of study, and provide substantial reductions in tuition. For details, contact the Coordinator of Financial Aid at the College.

LOANS

Graduate students may be eligible for various types of educational loans. The New York Higher Education Assistance Corporation offers

loans to residents which are interest free until after college, and then charges seven percent annual interest under current regulation. Repayment terms are arranged after graduation.

A graduate student who is a U. S. citizen may borrow up to $2,500 a year under the Student Loan Program of the National Defense Education Act of 1958. No interest will accrue until nine months after leaving college, and then it is at three percent. Part of the loan will be canceled if the student becomes a public school teacher or college teacher or enters military service. A ten-year repayment period is allowed.

OTHER FORMS OF SELF SUPPORT

A limited number of graduate students without assistantships or fellowships may be employed at an hourly rate to assist in laboratories and other College activities. Such hourly employment does not include free tuition.

Employment also may be sought on a part-time basis through department chairmen, the Student Affairs Office of the College, or the Syracuse University Placement Office.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Graduate Degree Programs

ENVIRONMENTAL SCIENCE

The environmental problems facing the world today are a complex product of man's interaction with his environment, not a simple sequence of technological difficulties. They derive from a dynamic interaction of scientific, technological, design and managerial factors with economic, political and legal ramifications. An unidimensional approach to this system from the viewpoint of a single discipline cannot integrate the information necessary to improve the system's operation.

Progress in this endeavor rests on difficult policy decisions in the public sector. Essential to the development of such effective policy alternatives is the expertise of individuals trained to consider the systematic nature of the problem. It is the purpose of the environmental science program to provide such training.

The graduate program in environmental science is an integrated, multidisciplinary scheme of course work and research unique to each student. It is designed to help the student develop a basic focus in one aspect of the environmental complex as it relates to other elements in the system of which it is a part. The research component of the program uses the systems approach to bring together students from diverse backgrounds in teams or task forces to research a particular environmental problem. Participants bring to the task expertise in science, planning, management, design or engineering, and each learns to relate one's particular competence to that of the others as they work toward the solution of a common problem. In the process each develops insights through the social, legal, political and communications factors that are integral parts of the total problem. The student develops an enhanced understanding of environmental problems and valuable experience in seeking their solution.

The aspects of natural resource utilization and the environmental system listed below suggest examples of possible foci for a program of graduate study and research. Environmental science encompasses these and others, many of which can be formulated only as man's understanding of his environment grows.

Some examples of graduate study areas in environmental science are: chemical ecology, ecology, environmental communications, fish and wildlife management, organic materials science, land and water resource planning, soil sciences, water resources and international forest resources.

Chemical Ecology involves the integrated investigation of ecological problems drawing heavily upon expertise in chemistry and biology. Current research areas involve the study of mammalian and insect pheromones using deer, antelope, beetles and moths. The studies have provided information which have suggested mechanisms for insect control and models for chemical communication among various animal species.

Ecology is by definition the collective interaction of organisms and their environment, which encompasses the realm of the biological sciences, the chemical sciences and the natural resource sciences. The focus of study may be in any of these broad areas but ideally it draws upon parts of all in support of the particular study area. Current investigations involve plant succession, plant communities and man, insect population ecology, wildlife ecology, aquatic animal ecology, animal behavior ecology, invertebrate community ecology, and applied forest ecology.

Environmental Communications includes the investigation of communicative modes such as journalistic, audio and video techniques and the effective development of these as they are related to the nature of, and solutions for, various environmental problems. This program draws heavily upon the communications facilities of Syracuse University and is designed to enhance the delivery of information to the public in regard to the scientific, managerial, engineering and design aspects of the current environmental situations. Current activities in this area involve interpretative conservation and liaison activities with public and private communications agencies.

Fish and Wildlife Management provides a focus for students to investigate the various biological and managerial components relating to these important resources. The demand in this area is for students who are dually trained in both the biological and managerial components as related to fish and wildlife and who can apply this training in real-world situations. Students with biological or resource management backgrounds would develop complementary alternate exposures in the other aspect. Current activities include habitat manipulation, recreational management, wildlife ecology, and fisheries development in the context of a collaborative focus.

Organic Materials Science provides a focus for the collaborative efforts of chemists, engineers and resource managers toward the development of new organic materials, new methods and techniques in the preparation and utilization of organic materials. Since one of the major sources of organic materials is our renewable and nonrenewable natural resources, the research efforts in this program have important implications in natural resource policy decisions.

Land and Water Resource Planning describes the integrative efforts of managers, designers, planners and engineers in the development of effective plans for development and preservation of natural resources and environment. Students are trained in the consideration of planning in the use of large forested open space resources as well as urban and suburban developmental plans which create aesthetically appealing, yet effectively planned and developed, resources in a community.

Soil Sciences as a study area, involves the collaborative efforts of silviculturists, soil physicists, plant and animal ecologists and engineers working together with this important substrate—soil—as the focus of attention. Current research activities involve biological productivity, effects of soil fauna on sewage treatment, fertilization in regard to fiber production and basic soil physics.

Water Resources includes the combined efforts of resource managers, biologists and chemists, environmental engineers and silviculturists in the investigation of the management and utilization of water resources, problems in water quality and quantity, relationships of water with land use and development, and the special processes or products which affect water quality.

International Forest Resources promotes the enrichment of a student's technical forestry background which will enable effective service in an international capacity in the field of forestry. It draws upon the expertise in the resource sciences, biological sciences and the engineering programs relevant to international forest problems with an international, national or regional focus.

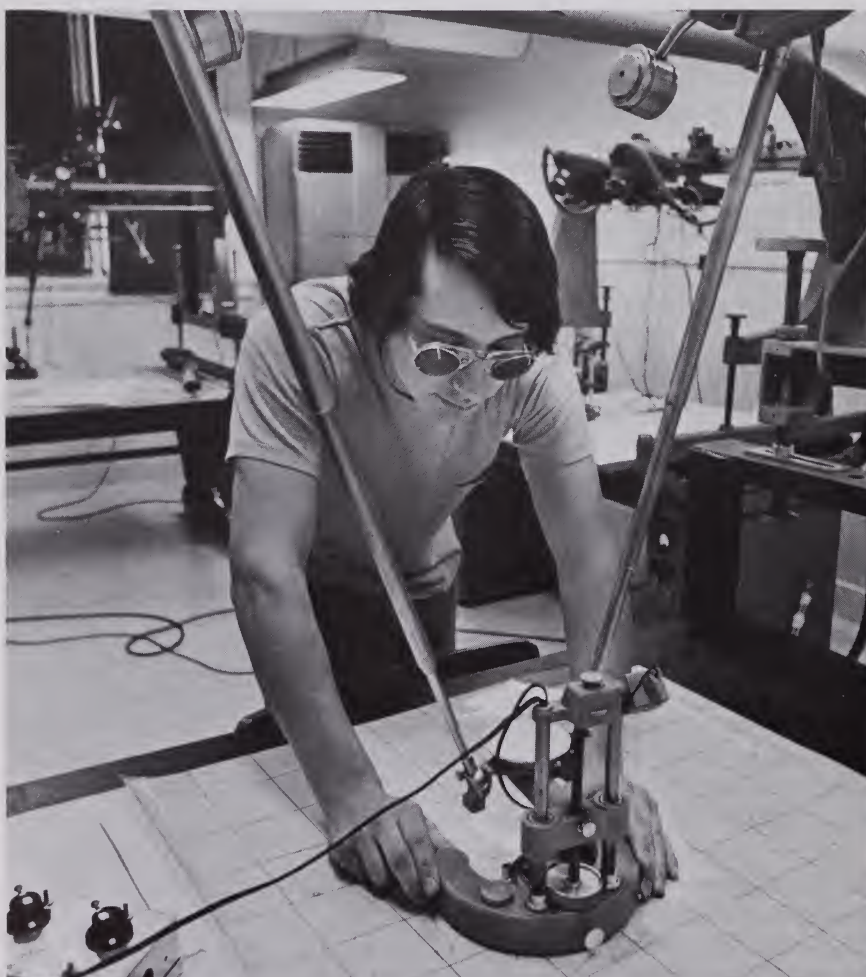
These study areas, then, are some of the examples of the kinds of multidisciplinary approaches a student may take toward developing the expertise and insights necessary to meet society's needs in regard to the environment.

The program is designed to be flexible in nature while developing an in-depth focus. It enables the student to apply prior academic training in a discipline to the solution of an environmental problem, while developing additional training with broader implications. Other important factors in the program are the resources of Syracuse University in the coursework areas of communications, policy, law, sociology and political science, all of which have become important in today's understanding of man's interaction with his environment.

The program in environmental science is, then, the systems approach toward environmental problems which draws upon and involves faculty, coursework, facilities and philosophies of all of the disciplinary degree programs which are described in the next few pages. The relevant pieces of these programs and the in-depth strength of them provides the necessary disciplinary support to make the concept of "multidisciplinary program" a viable entity.

DISCIPLINARY DEGREE PROGRAMS

The following disciplinary degree programs are grouped to reflect the organizational focus of the faculty within the four Schools at the College of Environmental Science and Forestry. These four schools are: the School of Biology, Chemistry and Ecology; the School of Environmental and Resource Engineering; the School of Environmental and Resource Management; and the School of Landscape Architecture. The faculty of these schools support the individual graduate degree programs as well as the College-wide degree program in environmental science.



SCHOOL OF BIOLOGY, CHEMISTRY AND ECOLOGY

STUART W. TANENBAUM, *Dean* (Microbial Ecology and Metabolism); MICHAEL FLASHNER (Enzymology)

Botany and Forest Pathology

TEPPER, *Chairman* (Anatomy and Morphogenesis); AMES (Morphogenesis); GEIS (Ecology); GRIFFIN (Mycology and Fungus Physiology); KETCHLEDGE (Ecology and Bryology); LOWE (Mycology); MANION (Pathology); McDOWELL (Fungus Physiology); SCHAEDLE (Physiology); SILVERBORG (Pathology); VALENTINE (Genetics); WANG (Mycology); WILCOX (Physiology of Growth and Development); ZABEL (Wood Deterioration)

The program in botany and pathology is designed to provide students with graduate level instruction in basic botanical and related natural and physical sciences. Research and thesis problems are generally designed to utilize forest organisms in the development of biological knowledge. Opportunities for graduate study within the program are offered in the fields of anatomy, morphogenesis, physiology-biochemistry, ecology, forest pathology, wood deterioration, mycology, genetics and taxonomy. Courses in climatology, meteorology, soils, ecology, bacteriology, botany, microbiology, genetics, mathematics, chemistry and statistics, all available in other departments at the College and at Syracuse University, provide additional support for the program.

Current areas of active research by departmental faculty are: *anatomy and morphogenesis*—factors that influence the development and form of root systems and regulate the development of root and shoot apices, cell differentiation in tissue culture; *physiology*—chemical regulation of organ growth, the nature and physiology of mycorrhizae, ion transport, mineral nutrition, biochemical aspects of cambial physiology, photosynthesis; *ecology*—dynamics of plant communities in the Adirondack Mountain Region and on the Allegheny Plateau, the influence of man on plant communities, the interaction of environmental factors during vegetational change, phytogeography and chemical ecology; *forest pathology*—disease of forest plantations, heart rots and cankers, tree rusts and physiogenic diseases; *wood deterioration*—the effects of stains and decays on wood use and their controls, the chemistry of wood decay, toxicity mechanisms and the bio-assay of toxicants; *mycology*—the taxonomy, sexuality, and morphology principally of wood-inhabiting fungi and microfungi; *fungus physiology*—the role of nucleic acids and intermediary metabolism in growth and morphogenesis; *genetics*—quantitative and population genetics, the heritability and natural variations in wood characteristics that are important in forest products and wood pulp; *taxonomy*—the identification, nomenclature and classification principally of fungi, bryophytes and vascular plants.

Illick Hall, the biological science building, provides faculty and students with modern facilities for botanical research. Special facilities include rooftop greenhouses, growth chambers, herbaria and special research laboratories for tissue culture, microchemistry, microtechnique, microscopy, radiochemistry, chromatography and computation. In addition, a cobalt-60 source, electron microscopy laboratory and a computer center are available at the College for student use. Extensive College forests, including most forest types of the Northeast, plantations and nurseries, offer exceptional opportunities for field study of forest plants and diseases.

Research in botany and forest pathology is supported by private industry, the U. S. Forest Service, the New York State Department of Environmental Conservation, the Research Foundation of the State of New York, a variety of Federal agencies and by the State of New York. In addition to direct project support, the grantees also provide for graduate research assistantships.

Entomology

SIMEONE, *Chairman* (Ecology and Wood-Inhabiting Insects); ALLEN (Ecology and Population Dynamics); BREZNER (Physiology); CAMPBELL (Population Dynamics); KURCZEWSKI (Morphology, Taxonomy, Behavior); LANIER (Ecology, Cytotaxonomy); MORRIS (Medical Entomology); NAKATSUGAWA (Toxicology)

Opportunities for graduate study in entomology are available to students with interests in both basic and applied aspects of insect-related problems. On-going research includes classical biological studies of forest insects and those causing the deterioration of wood, as well as diverse areas such as host-parasite relationships, host selectivity, population dynamics, insect physiology, dehydrogenases, mechanisms and enzymology of insecticide detoxification, biochemical systematics, comparative behavior, insect communications, taxonomy, histology and cytology and medical entomology. Selected problems may also concern the economic impact of forest insects as well as chemical, biological and silvicultural aspects of insect control.

Interdisciplinary pursuits are encouraged in chemical ecology, genetics, forest pathology, vertebrate entomology, immunology and climatology involving other departments at the College, Syracuse University, and nearby Upstate Medical Center of State University of New York. Areas of specialization are enhanced by supporting courses in these other disciplines. Students interested in insect ecology, chemical ecology, physiology or taxonomy, for example, may pursue these subjects relative to plants and other animals by selecting courses in botany, silviculture, zoology, biochemistry and applied mathematics.

Students and faculty have a wide range of field and laboratory facilities available for research. The several forest properties represent varied forest environments, while Illick Hall provides modern controlled facilities and instrumentation. More than 18,000 square feet of indoor space is available, with access to an electron microscopy laboratory and

scanning electron microscopes, environmental chambers, ultracentrifuges, nuclear magnetic resonance equipment, gas chromatograph, isotope laboratory, a cobalt source for irradiation, a soundproof room, glasshouses and an insectary complex affording subjection of insects to controlled as well as ambient weather conditions. The taxonomic museum houses nearly 100,000 insect species deposited by entomologists for more than half a century. A computer center provides services in all phases of entomological research.

Forest Zoology

ALEXANDER, *Chairman* (Vertebrate and Wetland Ecology); BEHREND (Wildlife Ecology and Management); BROCKE (Bioenergetics and Wildlife Ecology); CHAMBERS (Wildlife Ecology and Management); DINDAL (Invertebrate Ecology); GRAVES (Physiological Ecology); HARTENSTEIN (Invertebrate Physiology); PAYNE (Wildlife Conservation); PRICE (Animal Behavior); TIERSON (Wildlife Management); VanDRUFF (Vertebrate Zoology and Wildlife Ecology); WEBB (Vertebrate Ecology and Wildlife Management); WERNER (Limnology and Aquatic Ecology); YOUNGS (Fishery Biology)

Graduate studies in zoology include both basic and applied research on animals of our natural ecosystems, including their associated soils and water. Programs are offered in vertebrate ecology, soil invertebrate ecology, physiology, population ecology, animal behavior, forest wildlife biology, aquatic ecology, forest wildlife management and fishery biology.

Many of the faculty and students are located in Illick Hall, the biological sciences building. Facilities include specialized laboratories for research in physiology, soil invertebrate ecology, animal behavior, aquatic biology and wildlife biology. An extensive collection of invertebrates is available, as well as the large Roosevelt Wildlife Collection. Various temperature-humidity chambers are available, including an environmental simulating chamber which programs and records light, temperature, humidity, altitude, wind and precipitation.

Graduate students may participate in an intensive research program in wildlife biology at the Archer and Anna Huntington Wildlife Forest, a 15,000-acre forest in the Central Adirondack Mountain region. Many forest types are present in varying stages of management. Four faculty members are year-round residents.

Field research may also be conducted at the College's Heiberg Memorial Forest and Experiment Station. Several other areas are located within a 35-mile radius of Syracuse, and frequently are used for research purposes. These include Onondaga County's Highland Forest; the Department of Environmental Conservation's wildlife management areas —Tioughnioga, Three Rivers, Howland Island and Cicero; the Montezuma National Wildlife Refuge; and privately-owned lands. A wide variety of ponds, streams and lakes in Central New York are regularly used by graduate students in aquatic ecology and fishery biology. Also, various forests, fields, aquatic areas and waste beds are used for invertebrate investigations.

These facilities and areas are supplemented by the services and facilities of the College's other departments, particularly the departments of botany and forest pathology, and entomology. The School of Environmental and Resource Management provides support in relating the managerial and silvicultural facets of forest resources to animal ecology and wildlife study programs. The College is adjacent to Syracuse University with its large department of biology, strong in physiology and developmental zoology. Available through this institution are programs in social sciences and engineering, including land use and environmental pollution.

The State University Upstate Medical Center also is nearby. Its facilities are available for graduate students whose research can benefit from the specialized library, equipment and faculty.

Examples of recent research include the ecology of forest wildlife species, movements of larval fish, domestication of Norway rats, waterfowl marsh ecology, wetland planning, nesting behavior, deer behavior, physiology of isopods, pesticides and soil fauna, physiology of hibernation and the population dynamics of deer.

Chemistry (Polymers, Natural Products, Biochemistry)

SMITH, *Chairman* (Physical and Polymer Chemistry); LaLONDE (Organic and Natural Products Chemistry); SARKO (Physical and Polymer Chemistry); SCHUERCH (Wood and Polymer Chemistry); SILVERSTEIN (Ecological Chemistry); SMID (Physical and Polymer Chemistry); SZWARC (Physical and Polymer Chemistry); TANENBAUM (Microbial Chemistry); TIMELL (Wood Chemistry); WALTON (Biochemistry)

Recent years have seen profound advances in the fundamental knowledge of chemical areas which have special significance for forestry and the environment. The following research areas have received active attention by both faculty and graduate students in the programs: polymer chemistry and physics, wood chemistry, biochemistry, chemistry of natural products including ecological chemistry, and organic materials sciences. (See also Interdisciplinary Program in Organic Materials Science.)

Requirements for a master of science or doctor of philosophy degree in chemistry include a research project and thesis, along with an appropriate program of courses at the College and at Syracuse University.

Specific projects may vary from year to year, since they reflect the current interests of the faculty. Current research projects with *physicochemical* emphasis are: the chemistry, physics, solid state and solution properties of natural and synthetic polymers, including studies in thermodynamics, statistical mechanics, crystallization, morphology, elasticity, conformation of macromolecules, optical properties, polymer catalysis, mechanism of polymerizations, polyelectrolytes, ion binding to macromolecules and ion pairing; chemistry of free radicals, radical ions and charge transfer processes; structure and properties of ionic solutions in nonaqueous media; crystal structure and morphology of cell wall constituents. Current *organic* chemistry programs deal with synthesis of special polymers such as high temperature aromatic block, stereoregular vinyl polymers, and polysaccharides, various aspects of natural products chemistry, but especially alkaloids and terpenes, isolation and characterization of insect and mammalian attractants. An active program on the structure and topochemistry of the *polymeric* wood components, hemicelluloses, lignins and celluloses is underway. In *biochemistry*, department members are studying mechanisms of action of plant growth hormones, biochemical regulation of seed germination, plant enzymology and ultrastructural plant cytology.

SCHOOL OF ENVIRONMENTAL AND RESOURCE ENGINEERING

ROBERT V. JELINEK, *Dean* (Computer Applications, Process Engineering, Corrosion)

Graduate studies and related research activities in the School of Environmental and Resource Engineering are concerned with optimum development and utilization of natural resources, including structure, properties and manufacture of solid and composite wood products, paper and related fibrous materials. Program elements include various aspects of site evaluation and enhancement, unit and system design, production and processing and qualitative and quantitative measurement and computation. Environmental conservation and pollution abatement are stressed.

In addition to the three formal degree programs in *Forest Engineering, Paper Science and Engineering* and *Wood Products Engineering,* the School faculty has recognized the need for a new program to synthesize the inherent strengths of each of these in an engineering systems approach. This program in *Production Systems Engineering,* currently offered on an experimental basis at the master's level, enables students with various engineering or science backgrounds to acquire an integrated view of production processes, stressing the whole production system and focusing upon interfaces among subsystems. For each student in this program, an individualized plan of regular courses and special studies is designed, centering on a thesis project in production system analysis or design.

Graduate research laboratories in the Hugh P. Baker Laboratory are well equipped for polymer studies, chemical and biochemical research. Instrumentation includes analytical and preparative ultracentrifuges, Warburg respirometer, recording infrared and ultraviolet spectrophotometers, mass spectrometer, differential refractometer, electron spin resonance spectrometer, nuclear magnetic resonance spectrometer, automatic membrane osmometers, solid and solution state light scattering photometers, recording polarimeter and optical dispersion spectrometer, several ultramicrotomes, electron microscopes, X-ray diffraction, instrumentation chromatography and cold laboratories, and radiochemical laboratories with counters for solids, liquids and gases.

Forest Engineering

TULLY, *Chairman* (Structural Design, Hydrology, Soil Mechanics); BENDER (Geodesy, Remote Sensing); BROCK (Analytical and Interpretive Photogrammetry); LEE (Systems Analysis, Computer Science); LILLESAND (Remote Sensing, Environmental Monitoring and Route Location); PALMER (Industrial Engineering)

The forest engineering program is primarily concerned with engineering analysis and design in concert with other pertinent disciplines for the holistic development of the natural resources associated with the forest environment. The program objective is to support the discipline by producing graduates with sufficient understanding of the forest environment and its resources, of the methodologies of scientific research, and of the principles of engineering analysis or design to work with competence in resource-related research, engineering design and management.

Individually designed programs leading to the master of science and doctor of philosophy degrees are available. Undergraduate backgrounds required depend upon the student's needs and interests in graduate study. The student may emphasize engineering measurements, analysis or design within the program's breadth of engineering concern for environmental influences and resource utilization. Successful programs of graduate study in forest engineering may be efficiently designed by students with bachelor of science degrees in engineering or in forestry, natural sciences, physics or mathematics.

Programs of emphasis on environmental engineering measurements may be designed in remote sensing, photo interpretation, geodetic engineering, analytical photogrammetry and photogrammetric systems. Programs emphasizing engineering analysis and design are available in water resource, transportation, harvesting and site engineering systems. Included are the monitoring, measurement and evaluation of physical parameters affecting water, soil, timber, vegetation and wildlife.

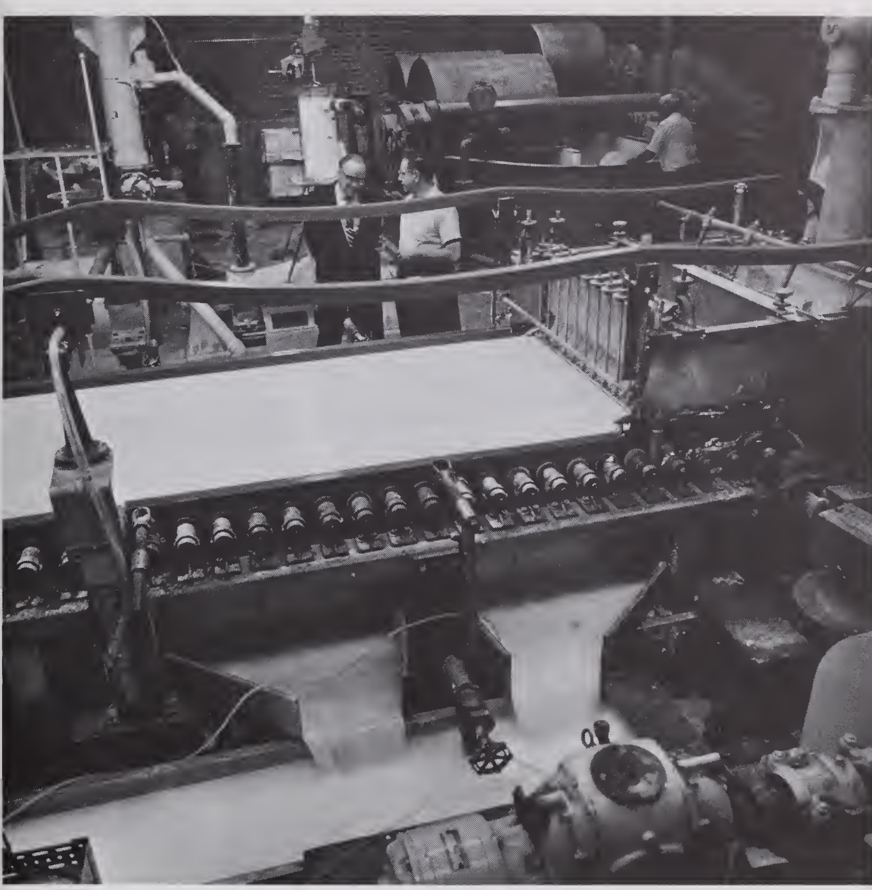
Support for the forest engineering graduate program is both internal and external. The internal support includes modern laboratory and instrumentation facilities in the Engineering Schools at both the College and Syracuse University. Exceptional departmental support exists for programs in environmental engineering measurements in the form of photogrammetric laboratories and the extensive forest properties owned by the College at which research may be conducted.

External support for the program comes from several active sources, including industrial, commercial and governmental. Over the past two decades, close cooperation has developed special study and research opportunities with these sources.

Paper Science and Engineering

BAMBACHT (Pulping, Papermaking, Water Quality); DENCE (Organic Chemistry and Lignin Reactions); GORBATSEVICH (Pulping, Bleaching, Paper Technology and Paper Properties); LEOPOLD (Organic Chemistry and Mechanical Properties of Fibers and Paper); LUNER (Mechanical and Surface Properties of Fibers, Films and Paper); MARK (Fiber Physics); MARTON (Paper Properties, Microscopy and Pulping); STENUF (Chemical Engineering, Instrumentation, Thermodynamics, Process Control, Metallurgy and Corrosion)

Outstanding for its vigorous growth and diversity of products, the pulp and paper industry is the fifth largest in the nation and exceptionally



strong worldwide. The need for professional men and women with advanced education in science, engineering and technology is increasing even more rapidly than the industry itself. The College pioneered in providing graduate study in this area in 1920 with the organization of the paper science and engineering program.

Since its inception, the program has maintained a singularly high position in professional education for the continuing development of the pulp, paper and allied industries. Its graduates, who are in constant demand, occupy positions of leadership throughout the world.

The graduate program reflects the strong trend toward diversification in the industry and offers opportunities for obtaining master of science and doctor of philosophy degrees in a variety of subjects related to the manufacture of pulp and paper. Advanced courses are offered in such diverse areas as engineering, physical and organic chemistry, polymer chemistry, paper physics and fiber morphology, as well as specific areas of pulping and paper properties.

Walters Hall, opened in 1969, is devoted exclusively to education and research in this field. Containing a large number of special purpose laboratories and highly sophisticated equipment, it houses one of the outstanding research facilities in the world, the Empire State Paper Research Institute.

Research activities aim to generate new information regarding the fundamentals, the science, the engineering and the technology of the papermaking process, utilizing advanced techniques such as electron microscopy, specialized spectrophotometry, nuclear magnetic and electron spin resonance and nuclear tracer methods. Also included is a modern chemical engineering laboratory, designed for studies in all phases of unit operations and processes, process control, thermodynamics and analog simulation.

The program maintains an experimental pulp and paper mill equipped with machinery and instrumentation for studies of pulping, pulp purification, reuse of secondary fibers, refining, paper additives and papermaking. This facility includes a paper machine, a 400 horsepower double-disk refiner, a two-pocket grinder for mechanical pulping and auxiliary equipment. Recent work has been directed to fundamental investigations of pulping, bleaching, additives, recovery of secondary fibers, the papermaking process, reactions of wood components during mechanical and chemical treatments, evaporation, fluid dynamics, heat transfer, the structure of wood and wood fibers and chemical and fiber recovery.

Wood Products Engineering

DAVIDSON, *Chairman* (Organic Materials Science); ANDERSON (Wood Quality-Growth Relations); CÔTÉ (Cellular Ultra-structure); DeZEEUW (Wood Anatomy, Structure-Property Relations); KYANKA (Applied Mechanics-Structures); MEYER (Wood-Polymer Systems, Radio-Isotope Techniques); MOORE (Bonded Materials Technology); PENTONEY (Mechanical Behavior, Fracture Mechanics); SIAU (Protective Treatments, Transport Processes); SKAAR (Wood Physics); G. SMITH (Materials Marketing); WHITT (Industrial Engineering)

While wood is one of the oldest structural materials known to man, its economic importance today is reflected in the fact that the annual tonnage of wood produced in the United States far exceeds that of any of the other major structural materials. This fact becomes even more important in this age of environmental and ecological concern because wood is the only major structural material that comes from a renewable natural resource, and demand is growing for more efficient utilization of available material. Improved efficiency must be based on solid scientific and engineering information. Thus research projects aimed at providing such information form the basis of the graduate program in wood products engineering. The major areas of specialization are: wood sci-

ence, wood products engineering (with emphasis on either structures or production systems) and product distribution systems.

Basic degree requirements for either a master of science or a doctor of philosophy degree include appropriate course work, which prepares the student to undertake a research project culminating in the writing of a thesis.

Recent research projects in wood ultrastructure have dealt with the interaction of coatings and glues with the wood substrate, cell wall development, the effectiveness of wood preservatives and the identification of natural inclusions in wood. The field of wood physics has had active projects in the permeability of wood, the mechanisms of fluid transport and the mechanisms of electric charge transport. Current projects are underway in the mechanical behavior of fiber networks, fracture mechanics of wood and the behavior of new structural designs which represent interests in the field of mechanics. In addition, there is a newly emerging field dealing with the properties of wood-based composite materials.

The laboratory facilities of the program include a modern mechanics laboratory which has a range of mechanical testing machines, a well-equipped physics laboratory with various electronic instrumentation, complete wood processing facilities including a sawmill and veneer mill, and an extensive foreign wood collection. In addition, the College has available a complete microscopy laboratory, containing both scanning and transmission electron microscopes and a wide variety of light microscopes and related equipment. Extensive equipment for chemical analysis and nuclear chemical techniques serve the College's research program.

SCHOOL OF ENVIRONMENTAL AND RESOURCE MANAGEMENT

CHARLES C. LARSON, *Dean* (Resource Policy and Administration, International Forestry)

Department of Managerial and Social Sciences

ARMSTRONG, *Chairman* (Industrial Economics, Resource and Market Analysis); BENNETT (Economic Theory, Economic Thought in Forestry); CANHAM (Regional Economics); CHRISTIANSEN (Forest Production Economics, Economic Systems Analysis); CUNIA (Operations Research, Statistics, Mensuration); GRATZER (Forest Recreation, Resource Management); HANSELMAN (Educational Communications); KASILE (Experimental Design, Biometrics, Statistics); KOTEN (Management, Systems Analysis); MORRISON (Sociology of Outdoor Recreation); MUNIAK (Environmental and Resource Administration, Planning); PETRICEKS (Macroeconomics, International Forestry Economics); STITELER (Biometry, Experimental Design, Computer Analysis); SULLIVAN (Mensuration, Operations Research, Industrial Forestry)

Department of Policy and Program Affairs

GRAVES (Resource Policy, Planning, Management); HENNIGAN (Resource Policy, Management); HORN (Law, Business Management)

Department of Silviculture and Forest Influences

JOHNSON, *Chairman* (Silviculture); BERGLUND (Silvics); BLACK (Watershed Management); CRAUL (Forest Soil Science); ESCHNER (Forest Influences); HERRINGTON (Meteorology); LEA (Silviculture); LEAF (Forest Soil Science); RICHARDS (Silviculture, Environmental Science); WESTFALL (Physiology-genetics, Tree Improvement)

Adjunct Faculty

DUERR (Managerial Economics, Resource and Market Analysis); ECHELBERGER (Forest Recreation Research); HEISLER (Meteorology); MINCKLER (Hardwood Silviculture); MOELLER (Forest Recreation Research); WILLIAMS (Forest Taxation)

Graduate education in the School of Environmental and Resource Management is offered under three broad programs: *Forestry Economics, Forest Management* and *Silviculture*. Within these programs, several areas of specialization are available.

Opportunity is also provided for students, in consultation with faculty advisors, to arrange areas of study specific to their interests and needs which may involve two or more programs or areas of specialization. Whatever the program, however, the basic purpose is to help the student acquire the tools and facility for disciplined, logical, critical, and constructive thinking and for clear expression in the selected field.

Prospective students who desire more information than is presented here for each of the graduate programs and specialties should contact the Office of the Dean, School of Environmental and Resource Management.

Forestry Economics

Graduate study emphasizing the economic aspects of forestry is offered in programs leading to master and Ph.D. degrees. The master's programs are designed to meet the needs of the graduate in forestry or forest products. They also serve the graduate in liberal arts, engineering or business whose interests point toward the economics of forest resource management. The aim is primarily to broaden the student's understanding of the content of forestry economics.

The Ph.D. program is for those who wish to make a career as professional forestry economists in research institutions, in the academic world, or in business or government. The goals are depth of understanding and familiarity with economic tools contributory to making competent decisions in resource economics, management and policy. Requirements are generally the same as those observed in economics departments of leading universities, except that the student completes specified work in the economics of forestry.

Instruction at the College is supplemented by the wide range of courses available in the Maxwell Graduate School of Citizenship and Public Affairs, the School of Management and other units of Syracuse University. Individual programs may include supporting courses in general economics, mathematics and statistics, operations research, business, international affairs and other social sciences and related fields. The substantial library resources, computer facilities and other resources of Syracuse University also supplement those of the College.

Graduate research in forestry economics within the School covers a broad spectrum. Examples of topics recently treated are: application of economic systems and operations research in timber management and in the manufacture and marketing of forest products; forestry investments in the face of uncertainty; economic models for public forestry decision-making; history of economic thought in forestry; the financing of public recreational improvements; and forestry investment criteria in developing nations.

Forest Management

Today's successful resource manager is one who can anticipate and prevent environmental troubles as well as attempt to remedy them; who is equipped not only to make current institutions function effectively but also to create new ones better fitted to changing social needs; and who can bring the strengths of many disciplines to bear on vexing environmental problems.

The forest management program has been designed to meet the need for capable managers by requiring broad acquaintance with several fields, strong integrative facility, long planning horizons and development (through separate curricula) of a comprehensive management team capable of joint attack on complex problems.

Specialized areas in forest management, policy and administration (land use planning), recreation management and quantitative methods are described below. Depth in each area is balanced by required understanding of both the physical-biological and the social systems which merge to form the context for forestry activity. Integration of fields is gained through study of current issues and application of managerial tools to real-world conditions. In all specialties, focus is on the goals of management, on advanced techniques for meeting them and on current and prospective issues and how to attack them. The rich resources of the College's other Schools and of Syracuse University are drawn upon freely in support of program efforts.

Forest Management

The forest management area focuses on the planning and implementation processes necessary to achieve integrated use of forests and related resources. The objective is to develop expertise sufficient for capable, professional resource management to satisfy a wide range of societal needs.

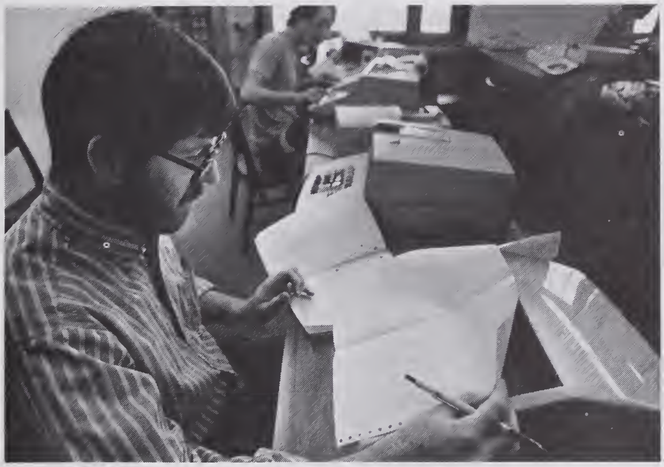
Broad knowledge of the operation of both biological and social systems is combined with skill in the use of managerial tools. Concepts in decision theory, information and organization theory, particularly, are applied to representative cases at varying levels of complexity. Syracuse University's School of Management and Maxwell School of Public Affairs offer a broad array of support courses. Students prepare themselves for any of a wide range of positions in research, program analysis, teaching, administration, budgeting and other phases of forest resources management with federal and state agencies and private firms.

Policy and Administration

Graduate study in the area of policy and administration prepares students for the broad range of responsibilities comprising the field of program administration in a public agency or a business at the executive, planning, budgeting, programming or operating levels. Advanced courses, special problems and seminars structured around man-resources relationships, resources policy issues, administrative management, resources management and environmental law are offered.

Students are encouraged to round out their academic programs through the offerings of other units of the College as well as the Syracuse University Maxwell Graduate School of Citizenship and Public Affairs and the School of Management.

The wide-ranging possibilities of course selection and the differing points of view that are available allow the student to tailor a program to meet specific career objectives. This breadth and diversity also offers the student an opportunity to develop talents for top executive leadership in various aspects of a field that is critical to the future of resource management.



Recreation Management

Graduate study in this area equips students with broad understanding of the nature and purposes of outdoor recreation and how it relates to natural resources, and builds the skills necessary for capable recreation management.

Individual programs combine study in resources management with relevant studies in the social sciences and development of analytical and political capabilities needed to implement plans and programs. The U. S. Forest Service Research Unit, situated on campus, provides strong support for research and independent study. Other schools of the College and of Syracuse University, treating such areas as planning, engineering, design and education, provide a wide range of supporting courses and facilities.

Graduates find employment in resource management agencies administering recreation areas; in national, state and local parks and recreation departments; in educational institutions and in private organizations involved in recreation.

Quantitative Methods

Study in the area of quantitative methods is designed to develop professionals skilled in mathematical and statistical problem solution and equipped to act as biometricians, mensurationists or in similar posts, with state and federal agencies and with private firms.

The program is designed primarily for students who have done their undergraduate work in areas such as biological sciences, forestry, wildlife or agriculture. Others, who lack background courses, may take this material concurrently. Students may concentrate in statistics, operations research or forest mensuration. Syracuse University's IBM 370 computer, programming banks and a wide range of courses in mathematics, statistics and quantitative methods give strong support to the program.

Silviculture

Concern for the forest ecosystem provides a major focus for graduate study in the silviculture program, with this ecosystem viewed in its role as a producer of goods and services and as a modifier of the physical environment in which man lives. It is in this context that translation of these concerns to broader questions of environmental quality is emphasized.

Silviculture, in its functional sense, is the bridge between fundamental biological and physical relationships and the applications of these relationships in the forest environment. Thus, graduate study in the many aspects of silviculture can cover a broad spectrum of disciplines, and can be as basic or as applied as the objectives of the student call for. Individual study programs are coordinated with various areas of specialization both within the department of silviculture and forest influences and with other departments of the College, with other units of State University of New York and with Syracuse University. A major strength is the close association of scientists representing a wide range of specialties, and both formal and informal cooperative arrangements between these scientists and their counterparts in federal and state agencies and in industry.

Physical facilities that are routinely used in graduate study within the silviculture program include well-equipped laboratories, specialized equipment and greenhouse facilities; and extensive College forests of nearly 25,000 acres on which are located natural and planted stands, seed orchards, a forest tree nursery and two large microclimate tower complexes with associated automated data acquisition systems and instrumentation. Major field installations include long-term northern hardwood stand improvement studies and the oldest continuous forest fertilization studies in the United States.

Included within the silviculture program are five fields of specialization that, singly or in combination, provide the graduate student with a wide array of coursework, research activities and faculty guidance all aimed at enhancing his understanding of the forest ecosystem. These specializations are silvics, silviculture, forest soil science, tree improvement and forest influences.

Silvics

Silvics is often defined as that branch of forestry which provides the scientific base for the cultural treatment of forest vegetation by (1) defining interrelationships within forest ecosystems and (2) cataloging general intraspecific characteristics of tree species. In a sense, silvics is the ecology of managed forest ecosystems, although unmanaged and natural forests are often studied intensively because they provide the benchmark conditions from which the silviculturist begins.

The specialist in silvics must maintain channels of communication with his colleagues in the basic disciplines, including those in soil physics, soil chemistry, micrometeorology and climatology, genetics and tree breeding, plant physiology, wildlife biology, entomology and pathology. In addition, certain tools, including a comprehensive knowledge of probability and statistics, the ability to use modern computers effectively, and a familiarity with measurement and sampling theory, are required by specialists in most applied sciences, including silvics.

The specialist in silvics is essentially at one focal point of much of what has been called fundamental forest research. His most useful function and worthwhile contribution to the field of forestry may very well depend on his ability to synthesize relevant material and, through experimentation, provide the silviculturist with information and possibly techniques for use in the cultural treatment of forest vegetation.

Silviculture

Classical silviculture can be defined as the theory and practice of the manipulation of forest ecosystems, including the control of vegetation establishment, composition, growth and quality. The nature of cultural treatments, the theories upon which they are based, and the biological, physical and social constraints to their implementation are stressed in this area of of specialization. Elements of forest vegetation are intensively examined from the dual standpoints of fulfilling management goals for goods and services while maintaining or enhancing biotic productivity for the future.

Management goals are considered to include all the many and varied goods and services that the basic forest resource is capable of supplying. Forest productivity is of basic concern; the student specializing in this area progresses through formal coursework and research toward an understanding of the effects of various treatments on the continuous, balanced and adequate supplies of wood, water, wildlife, recreation opportunities and amenity values. While major emphasis relates to treatment of tree stands for their continued production of wood products, increasing attention is directed to the cultural practices important for primarily noncommodity forest values.

The silviculture graduate specialization is aimed at preparing foresters to understand and evaluate forest ecosystems in whatever depth may be required, and to prescribe treatments or further experimentation to attain management objectives or increase knowledge toward this end.

Forest Soil Science

Graduate studies in this area of specialization may be directed toward aspects of soil science related to the quantity and/or quality of goods and services in the management of resources of nonagricultural lands, and the impact of management practices on environmental quality. These include soil moisture, soil temperature, and nutrient element status interrelationships in the evaluation of soil productivity; evaluation of ecosystems to quantify nutrient element balances and cycling; amelioration of soils for increased productivity; and impact of various land-use practices on soil productivity.

Modern well-equipped laboratories are available for graduate student use in plant, soil and water chemical analyses; soil water-holding capacity and compaction; infiltration and runoff; and other chemical and physical property investigations. The extensive College properties noted previously permit forest soil research to be conducted under a wide variety of environments and ecological conditions.

Programs are coordinated with other areas of specialization through cooperation among departmental personnel, with other departments of the College, Syracuse University and the U. S. Forest Service.

Tree Improvement

Graduate study in tree improvement is designed to educate highly competent people at the master's and doctoral levels and to derive new concepts in applied forest genetics. A broad spectrum of basic and advanced courses is available at the College and at Syracuse University.

In research, the student has the flexibility and opportunity to pursue varied research interests as well as contribute to long-term basic problems. Current active and potential research problems include the genetics of wood quality, ozone resistance in eastern white pine, the genetics of pest-host relationships, the biology of monoterpenes and resin acids in forest trees, and genecological variation in forest trees. Graduates are qualified to fill a variety of positions in research, teaching or tree improvement operations.

Forest Influences

Forest influences as an area of graduate study includes all the effects resulting from the presence of forest trees and associated vegetation on climate, the hydrologic cycle, erosion, floods and soil productivity. Health considerations and human comfort have often been included in older definitions of forest influences, and are assuming greater importance today with our growing concern for the environment.

Included among the principal studies in this area are energy exchange between forest and atmosphere; moderation of urban environments by vegetation; soil and slope stability; and watershed hydrology, including snow.

Graduates fill a variety of positions in research, teaching and public and private management, as watershed management specialists, hydrologists, environmental officers, meteorologists and forest ecologists.

SCHOOL OF LANDSCAPE ARCHITECTURE

BRADFORD G. SEARS, *Dean* (Natural Area Studies)

CURRY (Urban Analysis and Design); EARLE (Art and Design, History of Environmental Development); FELLEMAN (Site Engineering, Resource Policy Administration); FREEMAN (Plant Materials, Site Design); HARPER (Regional Environmental Planning); LEWIS (Community Planning, Systems Dynamics, Gaming Simulation); MACEY (Natural Design Determinants, Environmental Impact Assessment, Basic Design); NIEMAN (Regional Planning and Environmental Impact, Man/Environment Relationships); POLLAK (Social Policy Planning and Analysis, Social Geography); REIMANN (Methods and Philosophy of Design)

Landscape Architecture

There has always been a need and a desire for man to adjust to his physical environment, or to modify it in order to meet his requirements for shelter, sustenance and communication. Society has reached the point in the latter half of the 20th century where economic and technological sophistication enables man to completely control the physical environment. It is within the balance between man and nature, and the manipulation of land as it relates to man's use, that the role of the landscape architect lies. The professional landscape architect is concerned with the quality of the condition and form of the physical/cultural landscape.

Because of this concern, the landscape architect may work at any scale, from small site design projects with their related designed amenities, to the orchestration of regional, national or international projects which attempt to develop policy for qualitative use of land.

Landscape architecture is about land and people. The very dynamics of this relationship has lead to a profession which is always changing to keep abreast of man's needs.

The MLA degree program offers the opportunity to study advanced concepts and methods in landscape architecture. It is normally completed in two years. The curriculum has three aspects: a sequence of required core courses; a series of elected courses; and a terminal study.

Studio courses, seminars and courses in methods and topics for environmental research form the required core sequence. The emphasis in these courses is on identification and definition of environmental problems, development of strategies for their solution and utilization of sophisticated methods and techniques in their resolution.

Complementary to the required courses, the degree candidate takes a series of elective courses normally chosen from the School, the College of Environmental Science and Forestry or Syracuse University. Each student orients the choice of elected courses according to personal educational objectives. The student may wish, for example, to specialize in one or generalize in the many disciplines related to the needs of the professional landscape architect. Upon the approval of the faculty, a student also has the opportunity to take a part of the elected course work in self-described independent study.

Each MLA degree candidate completes the degree requirements by preparing a well-documented terminal study and satisfactorily defending the work in an oral examination. The terminal study is normally completed during the fourth semester of residence.

Research at the School, both sponsored and independent, has two major thrusts. The first is applied research. Here emphasis is to develop greater sophistication in contemporary methods and techniques used to solve real environmental problems. The second is original research, where the emphasis is to develop new data, criteria or methods which can be used in solution strategies for environmental problems.

The College library and the several libraries on the Syracuse University campus offer excellent in-depth reference material to support study programs. Facilities at the School are extensive. They include adequate studio and office space as well as reproduction, model making, photographic and audio-visual equipment. The College maintains a computer center which is used primarily for instruction and is available for individual use by graduate students. The College also has a fully equipped video tape recording (VTR) studio and photogrammetric labs.

The School is unique in its location within the College of Environmental Science and Forestry. This situation provides the MLA candidate with the opportunity to draw upon information and knowledge in ecology, natural sciences, resource management, forestry and many other

related environmental concerns. In addition, the relationship with Syracuse University provides the School with a wide-ranging human and physical resource base.

The Syracuse area has the largest concentration of landscape architectural firms in the State, outside of New York City. With a metropolitan population of nearly 500,000, the city has many opportunities for urban-oriented study. Also, the city's central location in upstate New York provides easy access to a rich variety of public lands and recreation areas which are planned and administered by a diverse range of governmental agencies and private owners.

Any student with a bachelor's degree, or the equivalent from a college or university of recognized standing, is welcomed to apply for admission to the MLA degree program. Along with the general application requirements of the College, each applicant is encouraged to submit any examples of work, such as academic reports, terminal projects and portfolios of creative endeavors or design work.

Graduate Course Offerings

Graduate students at the College of Environmental Science and Forestry not only have the academic and research resources of their own institution, but also the resources of nearby Syracuse University and State University Upstate Medical Center.

In graduate programs at the College, Syracuse University courses are used extensively in the fields of mathematics, physics, chemistry, biology, engineering, economics, business, and citizenship. The State University Upstate Medical Center has courses available for graduate programs in the areas of anatomy, biochemistry, cytology, microbiology, and physiology.

DESCRIPTION OF COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY COURSES

The courses offered by the College are grouped by general subject areas, and the number of credit hours appears after the course title. A credit hour means one recitation (or lecture) hour per week. Three laboratory hours are equivalent to one lecture hour.

Course Numbering System (Effective June, 1973)

Code Levels:

500–599 Graduate Courses designed expressly for graduate students, in areas supporting their specialization or interdisciplinary program, or for fifth year professional students with baccalaureate degrees (e.g. BLA students with B. S. in Environmental Studies), and available for undergraduate credit by selected upper division undergraduate students with superior academic records.

600–699 Graduate courses designed for beginning graduate students. Undergraduates are permitted admission only by petition with a well-documented justification approved by the undergraduate advisor and curriculum director and the instructor of the course.

700–899 Advanced graduate courses designed primarily for second and third year graduates and beyond, but available to all graduates.

900–999 Special graduate courses available only to doctoral students.

COURSE OFFERINGS

APPLIED MATHEMATICS (APM)

500. Introduction to Computer Programming for Graduate Students (3)

The basic course in computer use offered by the College. It is intended to provide the student with the skill and understanding needed to utilize digital computer languages for problem solving. The course includes a rather detailed study of Fortran IV, plus some discussion of an Assembly language and moderate study of Cobol and APL. To provide completeness, some attention is also afforded to techniques of representing information, managing files, error control and to operating systems and job control. This course or a demonstrated equivalent is a prerequisite to individual student use of the College computer facilities. Fall and Spring.

593. Introduction to Analysis of Variance (3)

Two hours of lecture, three hours of lab. One and two-way analysis of variance, multiple comparisons, subsamples, unequal sample size, tests of hypotheses, statistical estimation, determination of sample size. Fall. Mr. Kasile.

Prerequisites: APM 471 or APM 491 or equivalent.

Note: This course will be dropped from the College offerings, effective Fall, 1976.

610. Statistical Analysis (3)

Two hours lecture, three hours lab. A treatment of statistical inference, including paired design, group design, linear regression and correlation, one way analysis of variance and some applications of chi-square. Calculation of statistics, tests of hypotheses and proper interpretation of calculated statistics. Fall. Staff.

620. Analysis of Variance (4)

Three hours of lecture and recitation, three hours of lab. Multiway classifications in the analysis of variance, with emphasis on the development of models, including randomized blocks, latin squares, split plots, and factorial designs with fixed effects, random effects, and mixed effects; multiple and partial regression and correlation (including curvilinear), using matrix methods; analysis of covariance, higher order contingency tables, distribution free methods, and sequential testing. Spring. Mr. Kasile.

Prerequisite: Graduate standing and an introductory course in statistics covering material through the one-way analysis of variance.

625. Introduction to Sampling Techniques (3)

Two hours lecture, three hours lab. Introduction to the scientific basis of sampling: selecting an appropriate sampling unit; choosing an efficient design; calculating sampling error; determining a sample size to meet stated objectives. Spring. Staff.

Prerequisites: APM 471 or equivalent.

660. Information Processing Fundamentals (3)

The course presents problem solving and analytical structures, and practice in their application by use of a digital computer. Selected portions from the two general processing categories of numerical analysis and information systems are presented for discussion and study. The purpose is to develop an awareness with some understanding and proficiency in automated problem-solving systems. Spring.

Prerequisite: Integral calculus and proficiency in computer programming.

760. Computer Applications (3)

A course presenting some discussion and practice in the application of computers to the solution of complex large-scale problems. A study of simulation techniques provides the opportunity to apply a computer to the solution of problems normally considered outside the realm of classroom experience. A study of some programming systems permits the opportunity to see how computers are used to solve their own problems of efficiency concerned with time, space and reliability. Spring. Mr. C. N. Lee.

Prerequisites: APM 460 and APM 491 or the equivalents.

ENVIRONMENTAL AND RESOURCE ENGINEERING (ERE)

696. Advanced Topics (2-3)
Lectures, readings, problems, and discussions. Advanced topics as announced in the areas of environmental or resource engineering, building on one or more of the disciplines of the undergraduate curricula. Fall and/or Spring. Staff.

ENVIRONMENTAL AND RESOURCE MANAGEMENT (ERM)

558. The Law of Natural Resource Administration (3)
Three hours of lecture and discussion. An introduction to the law concerning the procedures, powers, and judicial review of public agencies responsible for the management of natural resources. Topics will include the extent of an agency's rule-making power and the rights of aggrieved parties to appeal from agency decisions. Spring. Mr. Horn.

Prerequisite: FMG 454 or equivalent course in public administration.

629. Environmental Impact: Principles and Strategies (3)
Three hours of lecture and discussion. Principles and theory of environmental impact and statements of impact as required by Federal Law. Administrative procedures for review and evaluation. Procedural strategy and effective constitution of statements for various governmental levels. Means of obtaining sources of authoritative information. Fall. Mr. Black.

641. Soil and Water Conservation (3)
Three hours of lecture and discussion. An integrated examination of the many aspects of the field of water and related land resource conservation in the United States. Topics include the evaluation and present status of planning, organizational, economic and legal constraints on the development of policies and programs of the Federal agencies, state and local government and private units. Fall. Mr. Black.

Prerequisite: Permission of the instructor.

642. Water Quality Management (3)
Three hours of lecture and seminar per week. The review of the ethical, historical, legal and technical basis for water quality management. Investigation of public policy on the international, Federal, state and local levels and the administrative methods and programs used to implement policy. Fall. Mr. Hennigan.

643. Urban Water Management (3)
Three hours of lecture and seminar per week. A review of the role of urban water management in water resources management. The problems and issues of providing water utilities services of water supply, drainage and waste water facilities including such considerations as planning, financing, local government, intergovernmental relations, state and Federal role, water institutions and applicable law. Spring. Mr. Hennigan.

662. Land Use Economics
Three hours of lecture/discussion per week. Study of the theory and methods of land use economics and the application of economic analysis to open space and regional planning. Emphasis is on understanding basic concepts, developing of operational methods and data sources. Case studies, outside readings, and guest speakers are utilized. Fall. Mr. Canham.

Prerequisite: One course in macro economics and one in micro economics and permission of instructor.

672. Open Space Planning (Recreation) (3)
Three hours of lecture/discussion per week. Study of methods and techniques applicable to open space planning in non-urban areas. Survey of literature and current research. Open space standards, classification systems and inventory methods. Development of plans for large scale recreation areas, and inclusion of recreation into regional plans. The interrelationship and conflicts between resource utilization/development and recreation/aesthetics reviewed through case studies. Fall. Mr. Gratzer.

Prerequisite: One course in outdoor recreation, one course in planning, and permission of instructor.

675. Social Psychology of Leisure Behavior (3)

Three hours lecture and discussion. Introduction to theory and research findings dealing with the sociological and psychological aspects of leisure behavior: field work and lectures demonstrate applications, particularly in outdoor recreation. Fall. Mr. Morrison.

798. Research Problems in Resources Management (Credit hours arranged according to nature of problem)

Special investigation and analysis of resources management problems where integrative relationships of several subject aspects of forestry are a major consideration. Fall and Spring. Staff.

FOREST BIOLOGY (FBL)

540. Chemical Ecology (3)

Two hours of lecture and one hour of discussion. A treatment of biological phenomena incorporating elements of ecology, physiology and chemistry as a basis for development and behavior and survival. Emphasis is on intra- and inter-specific relationships involving chemical messengers at the organismal population and community levels. Spring. Mr. Simeone.

Prerequisites: Organic chemistry, general ecology, general physiology.

575. Evolutionary Genetics (3)

Note: Syracuse University No. Bio 545

Three hours of lecture. Principles of evolution and the role of factors causing population changes, such as selection, breeding system, mutation, population size and structure, migration and genetic drift are discussed. Theoretical population genetics models and experimental population studies are related to evolutionary theory and studies of natural populations. Species formation and the evolution of isolating mechanisms are considered. Spring (even calendar years). Mr. Valentine and Mr. Drugar.

Prerequisite: FBL 370 or permission of the instructor.

576. Laboratory in Evolutionary Genetics (1)

Note: Syracuse University No. BIO 546.

Three hours of laboratory. Techniques and procedures for population studies and their application in experimental population genetics and in the analyses of natural populations. Spring (even calendar years). Mr. Valentine and Mr. Drugar.

Corequisite: FBL 575.

615. Advanced Limnology (4)

Note: SUNY Albany No. BIO 516.

Eight weeks, two full days a week. Comprehensive analysis of primary and secondary producers in a selected series of Adirondack lakes and streams. Lecture discussion sessions to serve to direct individual student projects detailing the flow of energy and circulation of matter in a variety of mountain habitats. Summer Session I & II, Cranberry Lake Biological Station. Mr. McNaught, SUNYA.

Prerequisite: BIO 202, 12 hours of biology.

621. Population Dynamics (2)

Note: SUNY Albany No. BIO 518.

Two full days per week for four weeks. Interrelationships of biotic and environmental factors that control population responses and interactions. Summer Session II, Cranberry Lake Biological Station.

670. Cytogenetics (3)

Two hours of lecture and one hour of seminar and discussion. Structure and behavior of chromosomes in animals and plants are considered. The effects of chromosomal aberrations and abnormal chromosome numbers on somatic and germ cell divisions, on the physiology and development of organisms with emphasis on human diseases and on populations including structure, speciation and evolution are discussed. Lecture demonstrations include tissue culture and cell hybridization methods for karyo-type analyses and somatic cell genetics. Spring (odd calendar years). Messrs. Lanier, Valentine and Neu.

Prerequisite: FBL 370 or permission of the instructors.

785. Histochemical Techniques (3)
One lecture and two labs. The techniques of the microtomecryostat, freeze-drying and freeze substitution, histochemical stains, and autoradiography in the elucidation of the constitution of cells and tissues. Spring (even calendar years). Mr. Tepper.
Prerequisites: Microtechnique and organic chemistry.

796. Topics In Biology
A course offered by the faculty for students interested in biology. Check the Schedule of Courses for details. Fall and Spring. Staff.

835. Membranes and Biological Transport (3)
Two hours of lecture and one hour of discussion. Composition, structure, and physical properties of membranes. Membrane functions including transport, bioelectricity and cell compartmentalization. Specific transport processes in biological systems. Fall (alternate years). Mr. Schaedle.
Prerequisites: One semester of biochemistry and an advanced physiology course, or permission of the instructor.

997. Biology Seminar (1)
One hour of lecture-discussion per week. The course emphasizes current concepts and developments in biology. Fall and/or Spring. Staff.

BOTANY (BOTANY AND FOREST PATHOLOGY) (FBO)

510. Mycology (3)
Two hours of lecture, three hours of laboratory. Fundamentals of the morphology, taxonomy, cytology, life histories and ecology of fungi. Laboratory experience in culturing and identification of fungi. Fall. Mr. Griffin.

515. Systematic Botany (3)
Two hours of lecture, three hours of laboratory. Identification, nomenclature and classification of flowering plants with special emphasis on local flora and on developing the ability to classify the plants of any region. Fall.
Prerequisite: FBO 310 or permission of the instructor.

530. Plant Physiology (2)
Two hours of lecture. Internal processes and conditions in higher plants with emphasis on physiological and biochemical concepts. For students majoring in the biological sciences. Spring. Mr. Wilcox.
Note: Botany majors electing this course for their concentration must also take FBO 531.

531. Plant Physiology Laboratory (2)
Two lab sessions. Introduction to current methods and procedures of physiological research including nutrition, tissue culture, photosynthesis, respiration and hormonal regulation of growth. Spring. Mr. Schaedle.
Prerequisites: FBL 330, corequisite FBO 530, or permission of the instructor. Advance tentative registration with the instructor is required.

561. Principles of Forest Pathology (3)
Three hours of lecture and discussion. Concepts and principles of tree diseases in relation to forest practice. Fall. Mr. Manion.
Prerequisite: FBO 360 or consent of instructor.

585. Plant Anatomy (3)
Two hours of lecture, three hours of laboratory. An introductory course in plant anatomy designed to familiarize the student with the organization and development of the primary and secondary plant body of higher plants. Spring. Mr. Tepper.
Prerequisite: FBO 100.

612. Phycology (2)
Note: SUNY Albany No. BIO 507.
Cranberry Lake Biological Station. Session II, every second or third summer. Two full days per week for four weeks. Study of the characteristic algae of selected Adirondack lakes and waters. SUNY Albany Staff.
Prerequisites: 15 hours of biology including general ecology and a course in the plant kingdom.

617. Adirondack Flora (1–2)
Note: SUNY Albany No. BIO 517.
One day a week for four/eight weeks. Cranberry Lake Biological Sta-

tion. Field study of the summer flora of the Adirondack Mountains. Sessions I and/or II. Mr. Baum.

Prerequisite: An elementary course in systematic botany.

625. Plant Ecology (3)

Two hours of lecture and discussion and one laboratory/discussion section per week. A first course in plant community ecology for beginning graduate students focusing on dynamics of community development and change and the processes of community analysis and description. Spring. Mr. Geis.

Prerequisite: A course in general ecology.

627. Bryoecology (2)

Two full days a week for four weeks. Field and laboratory work at the Biology Station. Study of the bryoflora of the major ecosystems of the Adirondack Mountain region. Summer Session I, Cranberry Lake Biology Station. Mr. Ketchledge.

Prerequisites: Survey of the plant kingdom; systematic botany; general ecology.

Special requirement: Students must be prepared to go on two overnight trips to isolated areas.

630. Fungus Physiology (3)

Two hours of lecture, one hour of discussion. Principles of growth, reproduction and differentiation of the fungi emphasizing the role of the environment in controlling fungal processes. Spring (even years beginning in 1970). Mr. Griffin.

Prerequisites: Two semesters of physiology or biochemistry.

636. Photosynthesis (3)

Two hours of lecture, one hour of discussion. Advanced study of photosynthesis on the cellular and organismal level. Specific topics will reflect basic concepts and current emphasis in this field. Fall of odd years.

Prerequisite: Two semesters of physiology or a course in biochemistry.

660. Phytopathology (3)

Two hours of lecture and discussion and three hours of Auto-Tutorial laboratory. Principles and concepts of plant pathology. Major diseases of ornamental plants, vegetable crops, fruit crops, field crops, and trees. This is an introductory plant pathology course for graduate students in all departments. Spring. Mr. Manion.

662. Wood Deterioration by Microorganisms (3)

Two hours of lecture, three hours of laboratory/field trip. Major types of fungus defects of wood and its products and principles of control. Special emphasis on chemistry of wood decay, wood durability, toxicants, lumber discolorations, heartrots and decay in forest products. Fall. Mr. Silverborg.

Prerequisite: Organic chemistry, FBO 360, or consent of instructor. Course offered in even calendar years.

715. Advanced Systematic Botany (2–3)

Lectures and laboratory. Field trips. Advanced study in the identification, nomenclature, and classification of flowering plants. Special emphasis on Gymnospermae, Compositae, and Gramineae. Fall.

Prerequisite: FBO 515 or equivalent.

725. Topics in Plant Ecology (2)

Two hours of seminar-discussion. An advanced course dealing with current research in plant community dynamics. May be repeated for additional credit. Fall.

Prerequisites: FBO 425 or 625 or consent of instructor.

733. Techniques in Plant Physiology (2–4)

Comprehensive study of techniques essential for research in plant physiology. Students may choose the instructors they wish to work with, and should consult the instructors for further details. Fall of every year. May be repeated for credit in different specialties. Staff.

Prerequisites: FBO 530 and 531 or an equivalent physiology course, biochemistry with laboratory, or consent of the instructor.

761. Topics in Phytopathology (3)

Two two-hour lecture-discussions. Discussions of specific phytopathological subjects. Topic selection is based on availability of expertise and will be announced in advance. Fall or Spring. Staff. This course may be repeated for credit in different specialties.

797. Botany Seminar (1)

Seminar discussions of subjects of interest and importance to the biology of plants. Fall and Spring. Staff.

798. Research in Forest Botany (Credit hours arranged according to nature of problem)

Advanced study in research problems in forest pathology, wood deterioration, tree physiology, anatomy, mycology, ecology, taxonomy and genetics. Typewritten report required. Fall and Spring. Staff.

810. Advanced Mycology, Homobasidiomycetes (3)

Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mr. Lowe and Mrs. Wang.

Prerequisite: FBO 510. Course offered in odd calendar years.

811. Advanced Mycology, Heterobasidiomycetes (3)

Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mr. Lowe and Mrs. Wang.

Prerequisite: FBO 510. Course offered in even calendar years.

812. Advanced Mycology, Ascomycetes (3)

Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mr. Lowe and Mrs. Wang.

Prerequisite: FBO 510. Course offered in even calendar years.

813. Advanced Mycology, Myxomycetes, Phycomycetes, Fungi Imperfecti (3)

Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mr. Lowe and Mrs. Wang.

Prerequisite: FBO 510. Course offered in odd calendar years.

825. Description and Analysis of Vegetation (3)

Two hours of lecture and discussion; one laboratory/field trip. An advanced course in measurement, sampling, and analysis of variables pertinent to vegetation structure and dynamics, and to vegetation-environment relationships. Fall.

Prerequisites: FBO 625, a course in statistics, or consent of instructor.

830. Physiology of Growth and Development (2)

Lecture. A study of the growth and development of plants and the physiological and biochemical processes that influence the development of form and structure in higher plants. Fall (even years). Mr. Wilcox.

Prerequisite: FBO 530, 585, and organic chemistry or permission of instructor.

870. Population Genetics (3)

Three hours of lecture. The principles and theorems of population genetics based upon gene frequencies and genic effects in theoretical populations. Effects of inbreeding, selection, mutation, fitness, migration, and other factors are considered. Composition and changes in natural and laboratory populations are related to genetic theory. Spring (even numbered years). Mr. Valentine.

Prerequisites: FBL 370, 371, one semester of calculus, APM 620, or permission of instructor.

899. Master's Thesis
Credit hours to be arranged

Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis
Credit hours to be arranged

Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

CHEMISTRY (FCH)

520. Nuclear and Radiation Chemistry (2)

The two one-hour lectures will cover the information required for the basic understanding of nuclear reactions, the types of radiation emitted, the instrumentation necessary to detect and measure this radiation, the principles of radioisotope tracer techniques and radiation chemistry which is the effect of radiation on organic systems. Visits to the Cornell Reactor and the Nuclear Medicine Department of the Upstate Medical Center will be arranged. Spring. Mr. Meyer.

Prerequisites: Physical, organic, and inorganic chemistry or by permission of the instructor.

Note: This course can be taken independently of FCH 521.

521. Nuclear Chemical Techniques (1)

The laboratory will consist of one four-hour laboratory class every two weeks, with one hour to be made up at the student's discretion to accommodate counting periods which extend over several weeks. A short movie by the AEC each week will be required for the sixth hour. The laboratory will give each student the opportunity to use the individual counting instruments, gain experience in the handling and preparation of radioactive samples and the use of the 1000 Curie cobalt source in radiation chemistry. Spring. Mr. Meyer.

Prerequisite: Physical, organic and inorganic chemistry or permission of the instructor. Advance tentative registration is required.

Corequisite: FCH 520.

530. Biochemistry I (3)

Three hours of lecture. General biochemistry with emphasis on cellular constituents and metabolic reactions. The chemical, physical and biological properties of amino acids, proteins, carbohydrates and their intermediary metabolism will be discussed. The chemistry of enzymes, energy transfers and biological oxidations will also be covered. Fall. Mr. Walton.

Prerequisite: One year of organic chemistry.

Pre- or corequisite: One year of physical chemistry.

531. Biochemistry Laboratory (2)

Six hours of laboratory. This course will stress techniques used in biochemical research. Techniques used include various types of chromatography, electrophoresis, and spectrophotometry and methods involved in the isolation, purification and assay of enzymes. Fall. Mr. Walton.

Prerequisite: One semester of quantitative analysis with laboratory.

532. Biochemistry II (3)

Three hours of lecture. Topics discussed are: application of tracer techniques to biochemistry, the chemical and biochemical properties of lipids, theories on the origin of life, photosynthesis and the biosynthesis of steroids and terpenes, plant aromatics, amino acids, porphyrins and other aspects of nitrogen metabolism. Spring.

Prerequisites: FCH 530 and its pre- and corequisites.

539. Principles of Biological Chemistry (3)

Three hours of biochemistry with emphasis on their relationship to biology. Topics include basic metabolic pathways, structure and function of proteins, enzymes, and nucleic acids, energy relationships and biochemical control mechanisms. Fall. Mr. Walton.

Prerequisite: A two-semester course in organic chemistry is desirable, but a one-semester course is acceptable. This course is not open to chemistry majors.

540. Chemical Ecology

This course is the same as FBL 540. Refer to description on page 44.

551. Polymer Techniques (2)

One hour of lecture and discussion and three hours of laboratory; lab reports. Techniques of polymer preparation: free radical solution and emulsion polymerization, copolymerization. Molecular weight determination by light scattering, osmometry, viscosity, ultracentrifugation. Structure characterization by X-ray diffraction, electron microscopy, nuclear magnetic resonance, optical rotatory dispersion, polarized microscopy, stress-strain and swelling equilibrium. Fall. Mr. Sarko.

Prerequisites: One year of organic and one year of physical chemistry.

552. Polymer Processing And Technology (3)

Industrial methods of production and processing of polymeric materials such as ribers, films, plastics, elastomers, foams, composites, adhesives and coatings, including discussions on the correlation between polymer structure and polymer properties. Spring. Mr. Smid and Staff.

650. Physical Chemistry of Polymers I (3)

Three hours of lecture. Includes: thermodynamics of polymer solutions, phase equilibria, fractionation, structure-property relationships, elementary chain statistics, molecular geometry, network elasticity, polyelectrolyte theory and viscosity. Fall. Mr. Smith.

Prerequisites: One year organic chemistry and one year physical chemistry.

651. Physical Chemistry of Polymers II (3)

Three hours of lecture. Viscoelasticity. The glassy state and glass transition temperature. The crystalline state and crystallization kinetics. Characterization of structure and morphology of polymer solid states. Survey of structure and properties of native polymers. Spring. Mr. Sarko.

Prerequisites: One year of organic and one year of physical chemistry.

652. Organic Chemistry of Polymers I (3)

Three hours of lecture. A broad survey of the chemistry of polyfunctional molecules and methods for their conversion to high molecular weight materials. Synthesis of a variety of specialty polymers and chemical reactions on natural and synthetic polymers. Some relations between molecular structure and useful properties. Fall. Mr. Caluwe.

Prerequisites: One year of organic chemistry.

653. Organic Chemistry of Polymers II (3)

Three hours of lecture. Kinetics and mechanism of polymerization processes, with emphasis on addition homo- and copolymerization relations initiated by radical, cationic and anionic initiators. Mechanism of stereospecific polymerization. Structure of polymers. Reactions on polymers and their modification for specific end uses. Block and graft polymers. Spring. Mr. Smid.

Prerequisites: One year of organic chemistry and one year of physical chemistry.

796. Special Topics in Chemistry (1–3)
(Credit hours arranged according to nature of topic)

Lectures, conferences and discussion. Advanced topics in physical chemistry, organic chemistry, or biochemistry. Fall and Spring. Staff.

798. Research in Chemistry
(Credit hours arranged according to nature of problem)

Independent research in physical and organic chemistry of synthetic polymers, physical and organic chemistry of natural polymers, organic chemistry of natural products, ecological chemistry and biochemistry. One typewritten report required. Fall and Spring. Staff.

830. Topics in Plant Biochemistry (3)

Three hours lecture and discussion. Covers topics in biochemistry unique to plants, including photosynthesis, biosynthesis of cellwall components, phenolics, terpenes, nitrogen metabolism, structure and function of plant hormones, biochemistry of differentiation and growth regulatory mechanisms. Spring (alternate years). Mr. Walton.

Prerequisites: FCH 530, FCH 532, or equivalents.

850. Organic Chemistry of Polymers (3)

Three hours of lecture, discussion and recitation. A broad survey of polymer forming reactions and polymeric structures. Special problems in stereochemistry, polymerization mechanisms and the synthesis of a variety of specialty polymers. Some relations between molecular structure and useful properties. Spring. Mr. Caluwe.

Prerequisites: One year of organic chemistry and FCH 450.

855. Physical Chemistry of Polymers (3)

Three hours of lecture and discussion. Introduction to statistical mechanics of polymers: general problem of random flight, chain statistics and conformations, partition functions: network statistics and rubber elasticity, birefringence, swelling, crystallization. Scattering phenomena: theory of light scattering, scattering from a sphere, scattering from liquids and solids, anisotropic scattering, X-ray scattering. Fall or Spring. Mr. Sarko and Mr. Smith.

884. Organic Natural Products Chemistry (3)
Three hours lecture. The chemistry of terpenoids, steroids and alkaloids with an emphasis on the determination of structure by both modern instrumental methods and chemical degradation. Biogenetic considerations and the confirmation of structure by synthesis are covered. Fall or Spring. Mr. LaLonde.
Prerequisite: One semester of advanced organic chemistry.

899. Master's Thesis (Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

997. Seminar (1)
Seminars scheduled weekly; an average of twenty to thirty seminars are given annually. Discussion of recent advances in chemistry. Credit is given only once to a student. Fall and Spring. Mr. Smith.

999. Doctoral Thesis (Credit hours to be arranged)
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

ECONOMICS (FORESTRY ECONOMICS) (FEC)

611. Economics of the Forest Business (3)
Two hours of lecture, three hours of laboratory. Economic evaluation of alternative uses of land, labor, and capital in the operation of forest properties and related marketing and processing enterprises. Emphasis is on application of principles and methods of economic analysis. Part of the term is spent in appraising a forest property and preparing a plan for its operation. Complementary to instruction in FMG 556. Spring. Mr. Christiansen.
Prerequisite: FEC 410 or permission of the instructor.

650. Forestry and Economic Development (3)
Three hours of lecture and discussion. Study of the role of forest resources in the process of economic development. Characteristics of forest resources which are important for economic development are analyzed in detail. Interrelationships between biological, technological, and institutional factors are stressed. Fall. Mr. Petriceks. Offered to seniors and graduate students in environmental and resources management. Open to others by permission of instructor.
Prerequisite: FEC 410 or its equivalent.

670. Economics of Outdoor Recreation (3)
Group discussion, lectures, guided reading and student essays on the economic aspects of outdoor recreation. Major topics include: supply and demand for outdoor recreation; theories of value and choice for both recreationists and recreation-resource managers; the role of outdoor recreation in economic development; and application of economic analysis to recreation planning and public policy issues. Spring. Mr. Canham.
Prerequisites: FEC 290 or 301, or equivalent; ERM 472 recommended.

710. Advanced Principles of Forestry Economics I (3)
Two hours of lecture, two hours of discussion. Intensive study of the microeconomics of forestry. Offered only to graduate students. Fall. Staff.

711. Advanced Principles of Forestry Economics II (3)
Two hours of lecture, two hours of discussion. Intensive study of the macroeconomics of forestry. Offered only to graduate students. Spring. Staff.

796. Selected Topics in the Economics of Forestry (Credit hours to be arranged)
Study of a topic in forestry economics, with emphasis on wide reading, original thinking and analytical writing. Fall and Spring. Staff.

797. Seminar **(1–3)**
Group discussion and individual conference. Critical examination of economic ideas and policies in forestry. Topics of interest to the group are selected for study, such as current developments in analytical method or in economy policy, the economic problems of small business in forestry, national or world requirements for the goods and services of the forest, or the economy of a forest region. Primarily for graduate students in forestry economics and world forestry. Fall and Spring. Staff.

800. History of Economic Thought in Forestry **(3)**
Three hours of discussion or conference. Systematic study and critique of the development of the thinking of foresters and economists with respect to some segment of the subject matter of forestry economics. Review of major individual contributions to thought and the influence of leading scholars upon the thinking of others. Appraisal of the leading schools of thought. Offered only to graduate students. Fall or Spring. Mr. Bennett.

830. Research Methods **(3)**
Three hours of discussion or conference. Study of the elements of research methodology and their application in identifying, analyzing and resolving problems in forestry economics. Fall. Staff.
Prerequisite: Offered to Ph.D. candidates in Forestry Economics. Open to others by permission of instructor.

840. Professional Workshop in Forestry Economics **(3)**
Two hours of seminar and one three-hour laboratory each week. FEC 840 is an internship-workshop in the interpretation of forest economics. The seminars are devoted to problems of programming, materials, instruction, testing, and evaluation. The laboratory incorporates leading a one-hour discussion group in F Econ 301, with preparation for that discussion group and with the writing of a report on the laboratory to be used in a subsequent seminar meeting. Fall. Mr. Bennett.
Prerequisites: Econ 605, Econ 606, and either FEC 830 or permission of instructor.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

ENGINEERING (FOREST ENGINEERING) (FEG)

552. Remote Sensing Interpretation **(3)**
Two hours of lecture, three hours of laboratory. An introduction to remote sensing technology as applied to detection and analysis of the forest environment, soil, water, climate and vegetation, as an aid to multiple use management. Fall and/or Spring. Staff.

563. Photogrammetry I **(3)**
Two hours of lecture and discussion, three hours of laboratory and discussion. Basic photogrammetric and photo interpretation concepts as a means of acquiring reliable data for engineering and management planning. Potentials, limitations, instrumentation, and unique requirements are considered. Fall and Spring.
Prerequisite: FEG 201 (or FMG 301 concurrent) or equivalent.

655. Remote Sensing Measurements **(3)**
Two hours lecture and three hours laboratory of an in-depth coverage of the theory of remote sensing of the electromagnetic spectrum and the various methods of phase and amplitude recording. Holographic, photographic and line scan recordings will be covered. Spring. Staff.
Prerequisite: FEG 363, Math 398, or equivalent.

660. Theory of Errors and Adjustments **(3)**
The theory of errors and adjustment of observations oriented toward geodesy and photogrammetry. Topics include error definitions, weighted observations,

method of least squares, matrix algebra in adjustments, variance-covariance matrix, the error ellipse and the general case of adjustment. Fall or Spring.

Prerequisite: Calculus; a beginning course in Statistics.

664. Photogrammetry II (3)

Mathematical theory of photogrammetry including space resection, orientation and intersection. The theory and use of photogrammetric analogue computers in providing resource engineering maps. Fall.

Prerequisite: FEG 563 or equivalent.

665. Terrestrial and Nontopographic Photogrammetry (3)

Two hours of lecture, three hours of laboratory per week. The theory and applications of terrestrial and nontopographic photo measurements. Photo-Theodolites, short-focus cameras and microscopes are used and calibrated to provide meaningful quantitative data from photographs. Spring. Mr. Brock.

Prerequisites: FEG 363 and APM 360 or equivalent.

674. Geometric Geodesy (3)

An introductory graduate level course for those without previous background in theoretical geodesy. Topics covered include position determination for short and long lines on the ellipsoid, the ellipsoidal triangle, the parametric equations, three-dimensional geodesy, and mappings of the ellipsoid. Fall.

Prerequisite: Permission of the instructor.

675. Astronomic and Gravimetric Geodesy (3)

An introductory graduate level course in Geodetic Astronomy and the gravity field of the Earth. Topics covered include updating star positions; precise time keeping; position determination by natural and artificial satellites; the fundamental concepts of Gravimetric Geodesy, including the potential function; attraction; undulations of the geoid and deflections of the vertical. Fall.

Prerequisite: FEG 674.

760. Analytical Photogrammetry I (3)

Two hours of lecture, three hours of laboratory per week. Mathematical theory of photogrammetry including space resection, orientation, intersection and aerial triangulation. Fall. Mr. Brock.

Prerequisites: FEG 363 and APM 360 or equivalent.

761. Analytical Photogrammetry II (3)

Two hours lecture, three hours laboratory. A continuation of FEG 760 leading to more extensive analytical solutions with frame and nonconventional photography. The distortions present in photographs are analyzed and camera and comparator calibrations are treated. Spring. Mr. Brock.

Prerequisite: FEG 760.

762. Instrumental Photogrammetry I (3)

Two hours of lecture, three hours of laboratory. The theory and practice of extracting information from photographs with the aid of photogrammetric plotters. Fall. Mr. Brock.

Prerequisite: FEG 363 or equivalent.

763. Instrumental Photogrammetry II (3)

Two hours lecture, three hours laboratory. The major subjects of study are photogrammetric optics, the theory and design of optical and mechanical plotters and automatic mapping systems. Spring. Mr. Brock.

Prerequisite: FEG 762 or permission of instructor.

797. Seminar (1)

Literature surveys and seminars on topics of Forest Engineering interest and importance. Subjects to be generated by faculty and students and to be announced prior to registration. Fall and Spring. Staff.

798. Research in Forest Engineering (Credit hours arranged according to nature of problem)

Independent research topics in Forest Engineering for graduate students who desire specialized knowledge or research experience. Tutorial conferences, discussions and critiques scheduled as necessary. One typewritten report (original and one carbon) required. Fall and Spring. Staff.

899. Master's Thesis
(Credit hours to be arranged)
Research and independent study for the master's thesis. Fall and Spring. Staff.

999. Doctoral Thesis
(Credit hours to be arranged)
Research and independent study for the doctoral dissertation. Fall and Spring. Staff.

ENTOMOLOGY (FOREST ENTOMOLOGY) (FEN)

580. Insect Morphology (3)
Two hours of lecture, three hours of laboratory. A comparative study of the external morphology of insects emphasizing evolutionary trends, especially modifications of homologous structures. Topics of special importance include intersegmental relationships, feeding, sensory mechanisms, locomotion and reproduction. Fall. Mr. Kurczewski.
Prerequisite: FEN 350.

610. General Insect Taxonomy (3)
Two hours of lecture, three hours of laboratory. Identification and classification of the important orders and families of insects; acquaintance with pertinent taxonomic literature and use of keys; and understanding of evolutionary principles and concepts and a knowledge of systematic theory and practice. Insect collection required. Fall. Mr. Kurczewski.
Prerequisites: FEN 350, FEN 580.

620. Aquatic Entomology (3)
Two hours of lecture, three hours of laboratory. The biology, ecology, and identification of fresh water insects, with emphasis on the role of aquatic insects in the hydrobiome. Fall. Mr. Brezner.
Prerequisite: FEN 350 or its equivalent.

630. Insect Physiology (3)
Two hours of lecture, three hours of laboratory. Study of the life processes in insects; introduction to modern physiological instrumentation and laboratory methods. Spring. Mr. Brezner.
Prerequisite: FBL 330.

660. Toxicology of Insecticides (3)
Two hours of lecture, three hours of laboratory. The mode and basis of action of various insecticides, phenomena of bio-transformation, selectivity, resistance, synergism and dosage-mortality relationships. Spring. Mr. Nakatsugawa.
Prerequisite: FBL 330, or equivalent course in physiology or biochemistry.

720. Population Dynamics of Forest Insects (3)
Two hours of lecture, one hour seminar. Interacting environmental factors which influence the relative abundance and distribution of forest insects, ecological principles as applied to problems in forest entomology, and pest management. Introduction to theories of population regulation and the study of the dynamics of forest insect populations; individual problem and seminar. Fall. Mr. Allen.
Prerequisites: FEN 350, FZO 520, APM 491, or equivalents.

796. Special Topics in Forest Entomology
(Credit hours arranged according to nature of work)
Special instruction, conference, advanced study, and research projects in the fields of insect toxicology, insect physiology, taxonomy of immature insects, phases of biology and ecology of insects. Typewritten report required in some fields. Fall and Spring. Staff.

797. Seminar (1)
One hour of conference per week. Assigned reports and discussion of topics in entomology. Fall and Spring. Mr. Nakatsugawa and Staff.

798. Research Problems in Forest Entomology
(Credit hours arranged according to nature of problem)
Comprehensive report required in some projects. Fall and Spring. Staff.

810. Advanced Insect Taxonomy (3)
Two hours of lecture, three hours of laboratory. Methods, procedures, and concepts of systematics. Examples and material will be drawn from among important groups of forest insects. Fall. Mr. Lanier.
Prerequisites: FEN 580 and FEN 610.

899. Master's Thesis
(Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis
(Credit hours to be arranged)
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

MANAGEMENT (FOREST MANAGEMENT) (FMG)

556. Management of the Forest Business (3)
Three hours of discussion. Overview of major business management principles and methods of operation in forestry enterprises. Emphasis is on general business concepts which forest managers must use. Actual case studies are basis of instruction. Complementary to FEC 611. Fall or Spring. Mr. Horn.

640. Analysis and Control of Forestry Operations (3)
Two hours of lecture, three hours laboratory. Applications of scientific methods to management decision problems of forestry operations with emphasis on data sources and reliability, model formulation, inventory control, equipment replacement, simulation, and critical path scheduling and costing. Fall. Mr. Sullivan.
Prerequisites: APM 471 or equivalent, FMG 340 and computer programming.

660. Management Principles and Processes (3)
Three hours of lecture. The principles of the art of managing manpower, providing greater depth in the concepts of management covered in FMG 454. Network analysis methods of management planning. Evaluation of personnel. Human relations concepts. The processes of problem recognition and decision-making, with consideration of the philosophical and qualitative elements of management science and information theory and their implications. Spring. Staff.
Prerequisite: FMG 454 or permission of instructor.

710. Research Methods (3)
Instruction regarding methodology in the approach to and solution of problems in Forest Management research. Restricted to graduate students in Forest Management. Spring. Staff.

720. Topics in Advanced Mensuration (3)
Two 1½ hours of lecture per week. Topics to meet students' interests are selected from the following areas: systematic, stratified and cluster sampling; ratio and regression estimates; photo interpretation and double sampling; sampling with unequal probabilities and 3P sampling; Continuous Forest Inventory (CFI) and Sampling with Partial Replacement (SPR). Introduction to Matrix Algebra and its application to Multiple Linear Regression, Weighted Least Squares Method, Volume Table Construction, and Analysis of Covariance by dummy variables. Applications of Mathematical Programming and simulation techniques to management problems involving optimization of cost functions. Fall. Mr. Cunia.
Prerequisites: FMG 322 and APM 491 or equivalent.

752. Applied Forest Management (3)
Principles and practices of forest management as applied to specific forest properties under the guidance of responsible public and private foresters. Several days are spent in the field studying forest conditions, organizations, operations, and problems. By observing actual forest operations, students become acquainted with the latest and most efficient forest practices in office and forest. Fall. Mr. Horn.

754. Advanced Forest Administration (3)
Critical appraisal of existing public, semi-public and private forestry agencies in the United States, and the comparative study of major administrative organizations and practices. Occasional inspection trips to forestry headquarters and field units and discussion of internal administrative problems with forest officers. Spring.
Prerequisite: FMG 454 or equivalent.

756. Management Concepts in Planning Forest Production (3)
Three hours of lecture and discussion. The theories and principles involved in planning the annual allowable cut and the resulting yearly cutting schedules. The influence of technical decision and socioeconomic pressures upon the level of cutting and the effect of the level of cutting upon the dependent industry. Fall or Spring. Mr. Koten.
Prerequisite: FMG 452 or equivalent.

797. Seminar (1)
Group discussion and individual conference concerning current topics, trends, and research in management. Fall and Spring. Staff.

798. Forest Management Problems (Credit hours arranged according to nature of problem)
Hours to be arranged. Special study of assigned problems with emphasis on critical thinking. One typewritten report (original and one carbon) required. Fall and Spring. Staff.

851. Operations Research I (3)
Two 1½ hours of lecture. Stochastic or models applicable to managerial process or systems analysis. Elements of probability theory, theory of games and decision theory, queuing model, simulation techniques with applications to queuing and inventory problems, and, if time permits, Markov chains. Fall. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

852. Operations Research II (3)
Two 1½ hours of lecture. Deterministic or models applicable to managerial problems or systems analysis. Elements of Matrix Algebra, solving simultaneous linear equations, mathematical programming, classical optimization techniques, LaGrange multipliers. Linear programming transportation and allocation models, dynamic programming, network analysis and, if time permits, quadratic, parametric and integer programming. Fall. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

899. Master's Thesis (Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis (Credit hours to be arranged)
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

FOREST ZOOLOGY (FZO)

520. Terrestrial Community Ecology (3)
Two hours of lecture, three hours of laboratory. Relations of terrestrial animals to their physical, chemical and biological environment. Emphasis on community principles, succession and terrestrial adaptations. Fall. Mr. Dindal.
Prerequisite: A course in basic ecology.

525a. Physical And Chemical Limnology (1)
Modular format, two hours of lecture/week for first seven weeks of fall semester. An introduction to the physics and chemistry of inland waters with particular emphasis on lakes.
Prerequisites: Junior standing, an introductory physics course and an introductory chemistry course. Fall. Mr. Werner.

525b. Introduction To Biological Limnology (1)
Modular format. Two hours of lecture/week for last seven weeks of fall semester. An introduction to the biology of inland waters. Particular emphasis is placed on the aquatic environment as a habitat and the effect of changes in this environment on the structure and function of the biological communities contained therein.
Prerequisites: FZO 525a. Fall. Mr. Werner.

525c. Limnology Laboratory (1)
One laboratory or field trip/week. An introduction to Limnology techniques and the taxonomy of aquatic organisms. Field trips to local aquatic habitats. FZO 525a and FZO 525b must be taken concurrently or previously. Fall. Mr. Werner.

620. Invertebrate Symbiosis (3)
Two hours of lecture and one three-hour laboratory. An introduction to the ecology and evolution of interspecific relationships of invertebrates. Spring, even years. Mr. Dindal.
Prerequisites: FBL 320, FZO 411.

626. Ecology of Adirondack Fishes (2)
Cranberry Lake Biological Station, Session II, every third summer. Half time for four weeks. Study of the ecology of fishes, with detailed individual investigation of the ecology of Adirondack fishes. Mr. Werner.
Prerequisite: FZO 416.

627. Field Ornithology (2)
Note: SUNY Albany, No. BIO 601
Two full days per week for four weeks. Field study of the ecology, distribution and behavior of birds of the Adirondack region. Techniques used in conducting field studies in avian biology will be emphasized. Summer Session A, Cranberry Lake Biological Station. Mr. Able, SUNY at Albany.

628. Vertebrate Population Ecology (3)
Two hours of lecture and one three-hour laboratory per week. Fundamental parameters of population structure and change with emphasis on vertebrate species. Spring. Mr. VanDruff.
Prerequisite: A course in general ecology.

630. Comparative Endocrinology (3)
Three hours lecture. General endocrinology with emphasis on the comparative functions of endocrine glands of animals. Spring. Mr. Graves.
Prerequisite: FZO 530 or equivalent.

650. Biology and Management of Waterfowl (2)
A consideration of the identification, life history, ecology and economic importance of waterfowl of the Atlantic Flyway. The management of local, flyway and continental waterfowl populations, including the establishment of hunting seasons, will be discussed. One Saturday field trip. Fall, odd years. Mr. VanDruff.

670. Vertebrate Behavior (3)
Two hours lecture, three hours laboratory. In-depth study of the major concepts of animal behavior associated with behavioral genetics, development orientation and social behavior. Spring. Mr. Price.
Prerequisite: FZO 570.

700. Forest Zoology Trip (2)
A 7 to 10 day trip to (1) agencies engaged in zoological research, management, and administration, or (2) regions or areas of unusual biological interest. A final report is required. Estimated student expense, $75.00. Fall or Spring. Staff.

720. Topics in Soil Invertebrate Ecology (3)
Two one-hour lecture-discussion periods and a three-hour laboratory. Study of literature relating to soil invertebrate microcommunities; taxonomy, culturing, and collection methods of soil fauna; student will conduct an individual research problem. Spring. Odd years. Mr. Dindal.
Prerequisite: Permission of instructor.

725. Zoogeography (3)
Two hours of lecture, three hours of laboratory. Geographic distribution of vertebrate animals, factors determining their distribution and nature of range occupied. Fall. Alternate odd years. Mr. Webb.

727. Seminar In Aquatic Ecology (1)
Two hours lecture and discussion. A seminar to explore in some depth areas of current research in aquatic ecology. Fall. Even Years. Messrs. Werner and Youngs.
Prerequisite: Six credits in Aquatic Ecology.

750. Advanced Wildlife Management (3)
Two hours lecture, three hours laboratory. Advanced wildlife management with emphasis on regional and administrative wildlife problems. Extended trips (two weekend trips) are required. Spring. Mr. Chambers.
Prerequisite: FZO 455 or permission of the instructor.

797. Forest Zoology Seminar (1)
Two hours of discussion and assigned reports on current problems and

new developments in forest zoology. Fall and/or Spring. Staff.

798. Problems in Forest Zoology (Credit hours to be arranged)
Hours to be arranged. Individual study of special problems in forest zoology. One typewritten report (original and one carbon) required. Fall and/or Spring. Staff.

830. Physiological Ecology (3)
Two hours lecture, one hour discussion. An examination of the concepts of animal adaptation to ecological change from a physiological point of view. Particular emphasis will be placed on physiological responses of the vertebrate digestive, excretory, endocrine, nervous and reproductive systems to modifications of the environment. Spring, odd numbered years. Mr. Graves.
Prerequisite: FZO 630.

835. Invertebrate Physiology (3)
Two hours lecture, three hours laboratory. A study of the physiologic mechanisms employed by invertebrates other than insects in coping with the exigencies of their environment. Fall or Spring. Alternate years. Mr. Hartenstein.
Prerequisites: FZO 411 and FZO 330.

899. Master's Thesis (Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

950. Topics in Wildlife Biology (1–3)
Hours to be arranged. Group study of a wildlife management topic. Fall or Spring. Mr. Chambers.
Prerequisite: Six credits of wildlife management courses.

970. Topics in Animal Behavior (2)
Two hours lecture and discussion. A seminar-type course designed to explore in depth selected and controversial subject areas in animal behavior. Fall or Spring. Mr. Price.
Prerequisite: FZO 670 or equivalent.

999. Doctoral Thesis (Credit hours to be arranged)
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

GENERAL FORESTRY (GFO)

751. World Forestry (3)
Three hours of lecture and discussion. World forest distribution and types; regional production and consumption of forest products; international trade in timber and related products; the role of forest resources in development; and special topics; tropical forestry, comparative forest policies and programs, forestry education, the problems of developing countries, international cooperation in forestry development, the role of the United States in world forestry, etc. Fall or Spring. Staff.
Prerequisite: Graduate status.

798. Problems in World Forestry (Credit hours to be arranged)
Provides an opportunity for the student to pursue his study of forestry, or some phase thereof, in a global, regional, or national (United States and Canada excluded) setting, and to gain experience in original thinking and analytical writing. Fall and Spring. Staff. For graduate students, primarily in World Forestry.

899. Master's Thesis (Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis (Credit hours to be arranged)
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

LANDSCAPE ARCHITECTURE (LSA)

522. Landscape Design Studio VI (4)
Twelve hours of studio per week. Studio problems, research, drafting, and field trips. Concentration on complex urban problems. Concern for social and psychological considerations of the individual and large groups of people, their interaction and resultant forms of the environment. Spring.
Prerequisite: Permission of instructor.

524. Experimental Landscape Design Studio V (16)
48 hours per week. The articulation of the study proposal established in LSA

425, as approved by faculty, through research, readings, field study with graphic and written documentation, and group discussion. Academic study in an off-campus location in an area of landscape architectural significance, as described and delineated in a student-prepared proposal approved by the faculty. Not available for graduate credit. Fall or Spring.

Prerequisites: LSA 425 or equivalent and LSA 423 or permission of instructor.

525. Landscape Design Studio VI (4)
Twelve hours of studio per week. Investigation of a problem in landscape architecture as proposed by the student and conducted in conjunction with faculty advisor. Spring.

Prerequisite: Permission of instructor.

527. Landscape Design Studio VI (4)
Twelve hours studio per week. Studio problems, research, reports, and field trips. Concentration on regional landscape problems, the techniques of their analysis and derivation of their significance to the practice of landscape design. Spring.

Prerequisite: Permission of instructor.

529. The Major Elements of Environmental Design (3)
Lectures, readings, discussions, and studios. The course presents an introductory survey of environmental design methods and associated skills and techniques. While studio work is engaged, no design background is required. Fall.

530. Herbaceous Plant Materials (2)
Two hours of lectures, study problems, assigned readings and field trips per week. Identification, understanding and design use of nonwoody plants. Fall.

Prerequisite: Permission of instructor.

532. Woody Plant Materials (3)
Three hours of lecture per week. Field study, lectures, slide presentations and readings. An elective course providing opportunity for extension of basic knowledge in the identification and design of woody plant materials in professional practice. Fall or Spring.

Prerequisites: LSA 533 and LSA 432 or permission of instructor.

533. Plant Materials (3)
Field trips and discussion. Ornamental woody plant identification. Observation and sketches of outstanding examples of planting design. Three weeks, Summer Session.

Prerequisite: Permission of instructor.

542. Highway Location and Design (3)
Two hours of lecture, three hours of studio per week. Lectures, assigned reading, studio projects, field trips. Environmental, engineering and human factors which determine highway location and design, particularly as they relate to landscape architectural concerns. Location, alignment, geometric design, drainage, roadbed construction, pavements, roadside development. Fall or Spring.

Prerequisites: LSA 343 and 440 or permission of instructor.

545. Professional Practice Studio II (2)
Three hours of studio, one hour of recitation per week. Studio problems research, discussion and recitation sessions on the processes and methods of office practice. Emphasis on all aspects of site-development. Spring.

Prerequisite: Permission of instructor.

547. Principles of Professional Practice (2)
Two hours of lecture per week. Lectures, assigned readings, reports, cost estimates, specifications, contracts, professional ethics, registration laws, professional practice. Spring.

Prerequisite: Upperclass standing.

562. Architecture (3)
Two hours of lecture, three hours studio. Discussion and investigation of the principles of architectural design and procedures of architectural practice. Functional building systems coupled with site and program considerations as to their relative impacts on architectural form. Spring.

Prerequisite: Permission of instructor.

595. Selected Readings in Landscape Architecture (1–3)
Exploration of selected readings in depth with individual independent study upon a plan submitted by the student and related to credit hours assigned. Upon approval of the instructor, the student may systematically investigate some subject area encountered in regularly scheduled courses or may initiate research on a variety of subject areas of determined relevance. Fall, Spring and Summer Session.
Prerequisite: 5th year status or permission of instructor.

597. Landscape Architecture Seminar (3)
Three hours of seminar per week. Discussion of current social, political, cultural and technological problems as to their relationship to the physical environment. Fall and Spring.
Prerequisite: Permission of instructor.

598. Research Problem (1–3)
Independent study of selected areas of environmental interest. Emphasis on a self-disciplined study, development of procedures and techniques to be employed in environmental design and planning. Engagement with specific sites and problems as proposed for study by individual communities. Fall and Spring. Enrollment at periodic intervals throughout the semester.
Prerequisite: Permission of instructor.

620. Graduate Studio I (4)
Twelve hours of studio per week. Disciplines and techniques used by the landscape architect in problem identification, analysis and solution strategies. Emphasis is on processes, not on product. Fall.
Prerequisite: Permission of instructor.

653. Environmental Land Use Planning (3)
An introduction to the interdisciplinary techniques and emphasis of environmental land use planning. Consideration of the underlying ecological and planning philosophies. Readings and discussions are used in order to familiarize students with the disciplines involved and the process of data analysis, synthesis and plan formulation. Case studies and research projects used to enhance understanding.
Prerequisite: Permission of instructor. Fall and Spring.

697. Seminar—Topics and Issues of the Physical Environment (2)
Discussion of current topics selected to acquaint the entering graduate student with a generalized view of the physical environment. Fall.
Prerequisite: Permission of instructor.

699. Research Method and Techniques (2)
The study of research methods, techniques and information sources pertinent to Landscape Architecture. Spring.
Prerequisite: Permission of instructor.

711. Human Behavior And Environmental Form (3)
Consideration of the nature and dynamics of people's movements in space as clues to their relationship with their environments. An examination of the basic social and behavioral concepts that relate to the human use of the urban environment. Concepts such as behavior patterns, territoriality, cognitive mapping, urban images, preference, neighborhood and community will be explored within the framework of "social space." The implications of such behavioral studies in the design of the environment will be considered.
Prerequisite: Permission of the instructor. Fall and Spring.

720. Graduate Studio II (4)
Twelve hours of studio per week. A multidisciplinary approach to the solution of one or more environmental problems of concern to the landscape architect. Because of the multivariable complexity of environmental problems, students pursuing various degree programs are invited to utilize this studio. Spring.
Prerequisite: LSA 620 or permission of instructor.

721. Graduate Studio III (4)
Twelve hours of studio per week. An extension of LSA 720 (Graduate

Studio II) with the engagement of more advanced projects. Fall.

Prerequisite: LSA 720 or permission of instructor.

730. Plant Materials IV (2)

Lecture, field work, trips. Special study of woody and herbaceous plant materials, greenhouse operation and other horticultural practices. Spring.

731. Plant Materials (3)

Seminars, individual conferences, field trips, readings. Guided individual study in aspects of plant materials related to landscape architecture. Fall or Spring.

Prerequisite: LSA 730 or permission of instructor.

740. Landscape Architectural Construction (3)

Lectures, drafting. Detailed study of special landscape construction problems. Preparation of estimates, contracts and specifications. Fall.

Prerequisite: LSA 542.

750. City and Regional Planning (3)

An introduction to methods of city and regional planning through the study of contemporary planning problems. Readings, discussions, and reports. Fall and Spring.

Prerequisite: Permission of instructor.

797. Seminar (2)

Two hours per week. Discussion of current topics, trends, and research related to landscape architecture, planning, and management. Fall and Spring.

Prerequisite: Permission of instructor.

798. Research Problem (Credit hours to be arranged according to nature of problem)

Special study of assigned problems relating to landscape architecture or planning, with emphasis on critical thinking. Fall and Spring.

Prerequisite: Permission of instructor.

799. Research Topics (2)

The study of research trends and current research needs pertinent to landscape architecture. During this course, the student is asked to develop a topic area and a proposed strategy for his terminal study. Fall.

Prerequisite: LSA 699.

899. Master's Thesis (Credit hours to be arranged)

Research and independent study for the master's degree and thesis. Fall and Spring.

PAPER SCIENCE AND ENGINEERING (PSE)

575. Unit Operations I: Fluid Mechanics and Heat Transfer (3)

Three hours of lecture and four hours of recitation per week for the first 9 weeks of the semester. The study of momentum and heat transfer. Pipeline and duct design, pump and blower selection, flow measurement, open channel flow, heat transfer by conduction, convection, radiation, including equipment design and selection. Fall. Mr. Stenuf.

Prerequisites: FCH 221 and 223, CHE 106, 116, 346, 356, PHY 103, 104, PSE 300, 301, 370 or equivalents.

576. Unit Operations II: Process Control and Mass Transfer (2)

Two hours of lecture and four hours of recitation per week for the last 6 weeks of the semester. The study and application of measuring means, remote signal transmission, and control elements. Response to signals, lag, dynamic error, cycling and other phenomena of process control are discussed in relation to the standard modes of control, including two-position, single-speed floating, proportional, proportional-speed floating, proportional-reset, proportional-reset-rate, cascade control, relation of the process variables to open and closed loop computer applications.

The fundamentals of mass transfer humidification and air conditioning as applied to industry and as found in the environment—climate and weather conditions. Fall. Mr. Stenuf.

Prerequisite: PSE 575.

578. Unit Operations III: Mass Transfer (3)

Three hours of lecture and four hours of recitation per week for the first 9 weeks of the semester. The study of mass transfer and application to the design and operation of equipment for drying, gas absorption, distillation and extraction. Each operation is treated as a practical unit complete with application of heat transfer, fluid flow, thermodynamics and instrumentation. Spring. Mr. Stenuf.

Prerequisite: PSE. 576.

579. Unit Operations IV: Recovery Processes Operations (2)

Three hours of lecture and four hours of recitation per week for the last 6 weeks of the semester. The study of industrial recovery processes operations including evaporation, filtration, sedimentation, centrifugation, small particle technology and fluidization, and reverse osmosis. Each operation is treated as a practical unit complete with application of heat transfer, fluid flow, thermodynamics and instrumentation. Spring. Mr. Stenuf.

Prerequisite: PSE 576.

661. Pulping Technology (4)

Two hours of lecture and six hours of laboratory. Discussion of pulping and bleaching processes. Effects of chemicals and physical variables on the wood components and pulp properties; chemistry involved. Experiments in pulping and bleaching, and pulp evaluation. Fall. Mr. Gorbatsevich.

Prerequisites: PSE 370, CHE 346 and CHE 256.

Note: A student may not enroll in or receive credit for both PSE 461 and PSE 661.

665. Paper Properties (5)

Three hours of lecture, six hours of laboratory and discussion. Evaluation and study of the physical, optical, and chemical properties of paper and the interrelationships existing between paper manufacturing methods, papermaking additives, test results and the ultimate properties desired in the finished paper. Fall.

Note: A student may not enroll in or receive credit for both PSE 465 and PSE 665.

666. Paper Coating (3)

Two hours of lecture, three hours of laboratory. Evaluation and study of the various coating processes and materials used by the paper industry to impart special properties to paper. Relationships of various components, flow properties of coating mixtures and evaluation of their effect on coated paper properties will be studied. Spring.

Note: A student may not enroll in or receive credit for both PSE 466 and PSE 666.

775. Industrial Thermodynamics (3)

The study and application of thermodynamics, including the first and second law, phase relationships, thermochemistry, the production of work and equilibrium relationships. Fall. Mr. Stenuf. Course given in even calendar years.

Prerequisites: CHE 346, CHE 356, or equivalent.

778. Metallurgy and Corrosion for the Paper Industry (3)

Three hours of lecture. The study and application of metallurgy and corrosion for the Pulp and Paper Industries. Fall. Mr. Stenuf. Course given in odd calendar years.

Prerequisites: CHE 346, CHE 356, or equivalent.

796. Special Topics (1–3)

Lectures, conferences, and discussions. Advanced topics in chemical engineering, chemistry and physics as related to fibers, pulps, and paper. Fall and Spring. Staff.

797. Seminar (1)

Discussions of assigned topics in fields related to pulp and paper technology. Fall and Spring. Staff.

798. Research in Pulp and Paper Technology
(Credit hours arranged according to nature of problem)

Hours to be arranged. Problems in pulp and paper technology are assigned to properly qualified graduate students. One typewritten report (original and one carbon) required. Fall and Spring. Staff.

Prerequisites depend upon nature of problem.

899. Master's Thesis
(Credit hours to be arranged)

Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis (Credit hours to be arranged)
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

SILVICULTURE (SIL)

553. Energy Exchange at the Earth's Surface (3)
Two hours lecture and three hours of laboratory. A comprehensive study of the physical processes taking place in the lowest layer of the atmosphere. Primary emphasis on the turbulent transfer of heat, momentum and water vapor and the expression of these fluxes in the microclimate. Spring. Mr. Herrington.
Prerequisite: SIL 452, physics, and calculus.

625. Productivity of Forest Stands (3)
Examination of forest tree and stand production variables as related to silvicultural manipulation. Analysis of stand response, such as rate of growth, stem form, product quality, tree quality and value. Preparation of stand treatment schedules. Spring. Mr. Richards and Mr. Johnson.
Prerequisite: Permission of instructor.

640. Advanced Wildland Hydrology (3)
Lecture, discussion, and laboratory sessions in advanced problems of forest and range hydrology, watershed management methods and techniques and evaluation of new methods of hydrologic data collection and analysis. Fall. Mr. Black.
Prerequisites: SIL 440 or FEG 340.

641. Watershed Analysis (3)
One hour of lecture and six hours of laboratory each week. Lecture and field experience in watershed characterization, inventory, and analysis in terms of land management problems. Fall. Mr. Black.
Prerequisites: SIL 440 and permission of instructor.

642. Snow Hydrology (3)
Three one-hour lectures per week and two three-day field trips. Physical characteristics of snow and the energy relations important in its accumulation and dissipation. Problems of measurement and prediction of runoff and melt. Potentials for management. Spring. Mr. Eschner.
Prerequisite: SIL 440 or FEG 340.

677. Advanced Forest Tree Improvement (3)
Two hours lecture and discussion, three hours laboratory. A study of advanced principles and techniques for genetic improvement of forest trees. Special emphasis is placed on selection and breeding for growth rates, wood quality and insect and disease resistance. Problems of tree hybridization, racial variations, sexual reproduction, and quantitative genetics in forest trees. Laboratory training in cytology and cytogenetics, pollen germination, vegetative propagation and other problems. Independent research problems will be undertaken by the student. Fall or Spring. Mr. Westfall.
Prerequisites: FBL 370 and 371, SIL 477.

730. Research Methods in Silviculture (3)
Three hours of lecture or discussion. Research concepts and methodology with particular application to silviculture and its related sciences. More appropriate to beginning students or before taking thesis work. Fall. Staff.
Prerequisite: Permission of instructor.

735. Forest Soil Fertility (Applied Studies) (2–4)
Two hours of lecture, one hour of discussion. Up to six hours of laboratory depending on number of credit hours. Influence of soil fertility on development and growth of seedlings and trees, and techniques involved to determine this influence. Chemical and biological analysis to determine levels of soil fertility. Nutrient element deficiencies and their correction by soil amendments and fertilizers. Term projects by the student will be undertaken. Spring. Mr. Leaf.
Prerequisites: CHE 332 and 333, FBO 530, SIL 435, or equivalent.

737. Forest Soil Physics (4)
Three hours of lecture and discussion and three hours of laboratory. Presentation of principles of soil physics including water flow, storage and availability, soil permeability, heat transfer, and their consideration as root environmental factors. Analytical procedures are introduced and evaluated. Applications of soil physics to silvics, soil fertility, watershed management and hydrology,

soil biology and land-use. Spring. Mr. Craul.

Prerequisites: SIL 332, 435, or their equivalents. Physical chemistry and integral calculus strongly recommended.

777. Quantitative Genetics in Forest Tree Improvement (3)

Two-hour lecture and discussion, three hours laboratory. Development of statistical models for determining heritability in forest trees. Breeding models and computer analysis application in forest genetics. Fall or Spring. Mr. Westfall.

797. Graduate Silviculture Seminar (1)

Three-hour class discussion per week. Assigned reports and discussion of silvicultural topics. Fall and Spring. Staff.

798. Research Problems in Silviculture (Credit hours arranged according to nature of problem)

Hours to be arranged. Fall and Spring. Staff.

899. Master's Thesis (Credit hours to be arranged)

Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis (Credit hours to be arranged)

Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

WOOD PRODUCTS ENGINEERING (WPE)

596. Special Topics (1–3)

Lectures, conferences, discussions, and laboratory. Special topics in Wood Products Engineering including techniques in scientific photography, microscopy, laboratory instrumentation, and computer applications as well as other topics of departmental interest. Fall and/or Spring. Staff.

Prerequisite: Consent of instructor.

666. Wood-Water Relationships (3)

Two hours of lecture, three hours of laboratory. Consideration of basic wood-water relationships and the drying of lumber and other wood products. Fall. Mr. Skaar.

Prerequisites: Physics, calculus, WPE 326 or equivalent.

688. Commercial Timbers of the World (3)

One hour of lecture, one hour of conference, three hours of laboratory, and assigned reading. Important commercial timbers of the world, their structure, physical properties, identification, supply and uses. Spring. Mr. DeZeeuw.

Prerequisite: WPE 387.

796. Advanced Topics (2–3)

Lectures, conferences, discussions, and laboratory. Advanced topics in Wood Products Engineering including techniques in scanning and transmission electron microscopy, laboratory instrumentation, and computer applications as well as other topics of departmental interest. Fall and/or Spring. Staff.

Prerequisite: Consent of instructor.

797. Wood Products Engineering Seminar (2–3)

Conference, discussion and reports analyzing current research and new developments, new literature and subject matter surveys in wood products engineering. Fall and Spring. Staff.

798. Research in Wood Products Engineering (Credit hours arranged according to nature of problem)

Investigations on directed study in wood products engineering including manufacturing, marketing, anatomy, physics, quality, and mechanical properties of wood. One typewritten report (original and one carbon) required. Fall and Spring. Staff.

880. Interpretation of Cellular Ultrastructure (2)

One hour of lecture, two hours of demonstration and discussion. The organization and sculpturing of the walls of plant cells; the cellulose microfibril, matrix and incrusting substances, and the warty layer. The ultrastructure and general function of cytoplasmic organelles in cells. The tools and techniques used for light and electron microscopic study of cells, and the interpretation of structural evidence. Directed study and discussion of the latest (current) literature on pertinent topics. Spring. Mr. Côté.

Prerequisite: Permission of the instructor.

899. Master's Thesis

(Credit hours to be arranged)

Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis

(Credit hours to be arranged)

Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

Index

	page
Admission Procedure	7
Admission Requirements	7
Assistantships	11
Biology, Chemistry and Ecology, School of	19
Botany and Forest Pathology	19
Calendar, Academic	2
Chemical Ecology	16
Chemistry	23
Costs	9
Course Offerings	41
Degrees, Doctoral	6
Degrees, Masters	5
Degree Programs	15
Degree Requirements	5
Disciplinary Degree Programs	18
Ecology	16
Economics, Forestry	31
Employment	13
Engineering, Forest	25
Entomology	20
Environmental Communications	16
Environmental and Resource Engineering, School of	25
Environmental and Resource Management, School of	30
Environmental Science	15
Faculty	3
Fellowships	11
Financial Assistance	11
Fish and Wildlife Management	16
Forest Influences	37
Graduate Record Examination	7

	page
Housing	9
Insurance	9
International Forest Resources	17
International Students	8, 12
Land and Water Resource Planning	17
Landscape Architecture, School of	37
Loans, Educational	12
Management, Forest	31
Management, Recreation	33
Multidisciplinary Degree Programs	15
Numbering System (for courses)	41
Organic Materials Science	16
Paper Science and Engineering	36
Policy and Administration	32
Quantitative Methods	33
Research	3
Residence Requirements	5, 6
Scholar Incentive Program	12
Scholarships	11
Silvics	35
Silviculture	34
Soil Sciences	17
Soil Science, Forest	36
Tree Improvement	36
Tuition and Fees	9
Tuition Waivers	12
Water Resources	17
Wood Products Engineering	28
Zoology, Forest	21

COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY
SYRACUSE, NEW YORK 13210

STATE UNIVERSITY OF NEW YORK
LET EACH BECOME ALL HE IS CAPABLE OF BEING
1948

BIOCHEMISTRY • BIOLOGY • CHEMICAL ECOLOGY • BIOMETRY • BOTANY • BUILDING CONSTRUCTION • CHEMISTRY • CELLULAR ULTRASTRUCTURE • ECOLOGY • ENVIRONMENTAL STUDIES • ECONOMICS • ENGINEERING • FOREST TECHNOLOGY • FIBER PHYSICS • ENTOMOLOGY • LAND USE • LANDSCAPE ARCHITECTURE • LIMNOLOGY • PAPER SCIENCE • MATERIALS MARKETING • METEOROLOGY • PAPER ENGINEERING • MICROSCOPY • MYCOLOGY • SOILS • REGIONAL PLANNING • NATURAL PRODUCTS ENGINEERING • OPERATIONS RESEARCH • ORGANIC MATERIALS SCIENCE • WATER RESOURCES • RESOURCE POLICY • PATHOLOGY • PHYSIOLOGY • POLYMER CHEMISTRY • PHOTOGRAMMETRY • PRODUCTION SYSTEMS ENGINEERING • OUTDOOR RECREATION • REMOTE SENSING • RESOURCE MANAGEMENT • SILVICULTURE • URBAN ANALYSIS • THERMODYNAMICS • WILDLIFE • WOOD PRODUCTS ENGINEERING • ZOOLOGY • WORLD FORESTRY • PATHOLOGY • WOOD SCIENCE • LAND USE • METEOROLOGY

GRADUATE STUDIES

STATE UNIVERSITY OF NEW YORK — COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

CORRESPONDENCE DIRECTORY

More information about the College may be obtained by directing inquiries to:

The State University of New York
College of Environmental Science and Forestry
Syracuse, New York 13210

Telephone (315) 473-8611

Graduate Studies and Admission
Office of Graduate and Instructional Affairs
200 Bray Hall
473-8631

Transcripts and Academic Records
Registrar
111 Bray Hall
473-8717

Financial Assistance
Coordinator of Financial Aid
109 Bray Hall
473-8884

Housing
Director, Married Student Housing
1528 East Colvin Street
Syracuse, New York 13210

The *Graduate Studies Bulletin* is Part Three of the CATALOG of the College of Environmental Science and Forestry. Part One is the *General Information Bulletin*; Part Two is the *Undergraduate Studies Bulletin*. All bulletins are available upon request at the above address. Published by the College of Environmental Science and Forestry August 1975.

State University of New York

COLLEGE OF

ENVIRONMENTAL SCIENCE AND FORESTRY

1975-76

Graduate Studies Bulletin

TABLE OF CONTENTS

Academic Calendar	2
Graduate Study at ESF	5
Requirements for Degrees	7
Admission	9
Expenses	11
Financial Assistance	13
Graduate Degree Programs	17
Course Offerings	41
Index	68

Academic Calendar

FALL 1975

Residences Open	August 31	Sunday
Labor Day	September 1	Monday
Counseling Begins	September 2	Tuesday
Registration	September 3-5	Wednesday-Friday
Classes Begin	September 8	Monday
Yom Kippur	September 14-15	Sundown Sunday to sundown Monday
Fall Recess	November 26-30	Wednesday-Sunday
Last Day of Classes	December 10	Wednesday
Reading Day	December 11	Thursday
Exam Period	December 12-19	Friday-Friday

SPRING 1976

Residences Open	January 11-12	Sunday-Monday
Counseling Begins	January 13	Tuesday
Registration	January 14-16	Wednesday-Friday
Classes Begin	January 19	Monday
Mid-semester Recess	March 6-14	Saturday-Sunday
Last Day of Classes	April 23	Friday
Reading Days	April 26-27	Monday-Tuesday
Exam Period	April 28-May 5	Wednesday-Wednesday
Commencement	May 9	Sunday

Graduate Study at ESF

Society is increasingly in the hands of those who have broad foresight and a balance of judgment in applying sociological and technical knowledge to guide human and environmental forces. Modern civilization—with its compelling demands from industry, government and educational institutions—requires persons who think objectively and constructively, and who act creatively and responsibly.

A purpose of the graduate years is to develop these persons. These years are a time of discovery and excitement, a time of answers and new insights, a time of personal productivity and contributions to scholarship. It is during the graduate education that the student develops the ability to think critically and analytically, to plan research, to design experiments, to work effectively with the basic research tools as well as specialized equipment, and to undertake the discipline of purposeful study toward a specific goal.

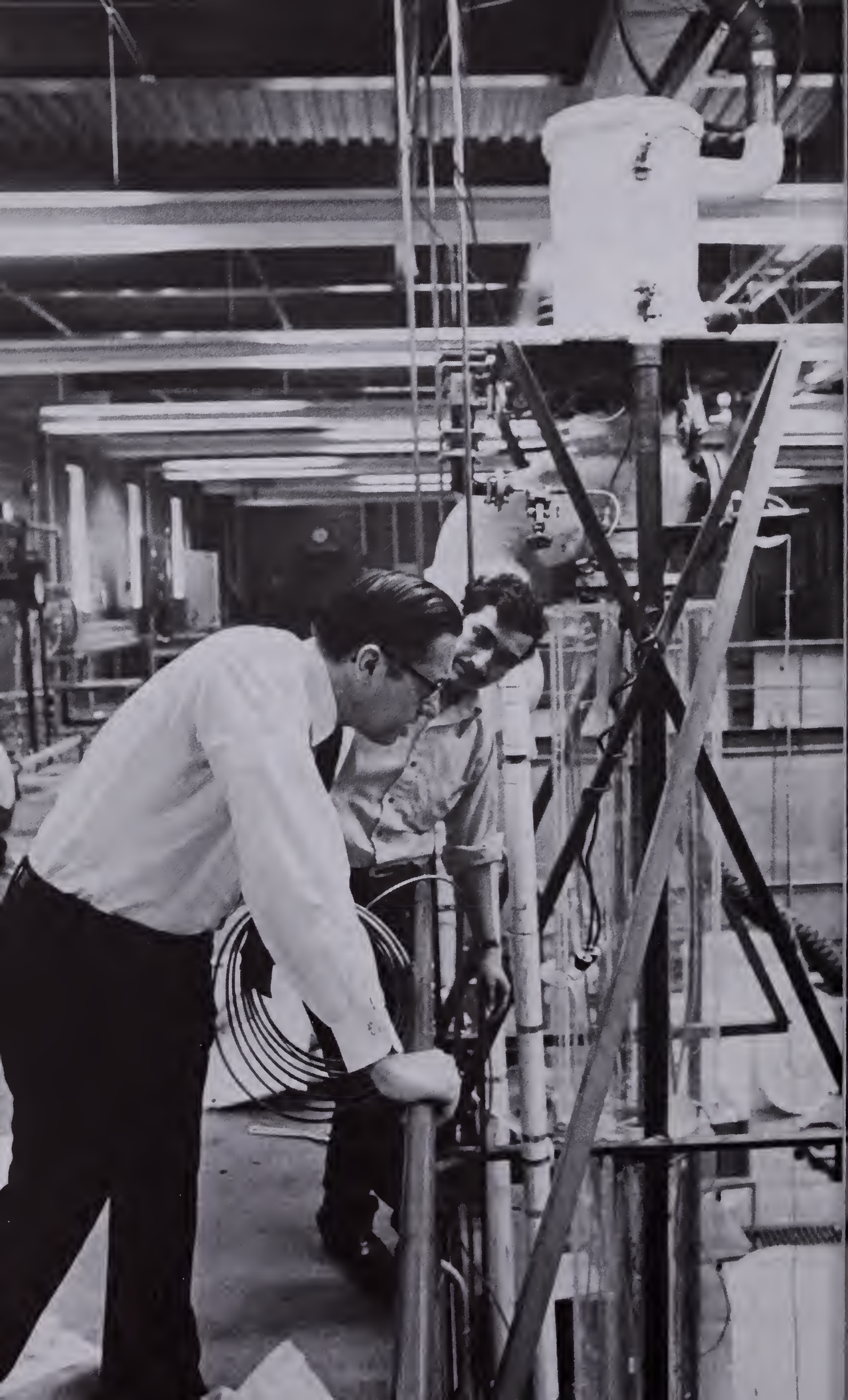
From its beginnings in 1911, the State University of New York College of Environmental Science and Forestry has served New York State and the nation in meeting the needs of its citizens in regard to the environment through education, research and public service. The faculty and students of the institution are committed to the resolution of immediate environmental problems, the development of the knowledge necessary to predict occurrences in the future, and the presentation of public policy alternatives that will both protect the environment and accommodate the real needs of society.

The major impetus for this inquiry lies in the research programs of the College in which the graduate students play an integral role with the faculty. The College has more than 150 faculty whose research interests in various aspects of environmental science involve more than 300 graduate students in master and doctoral degree programs.

The College currently supports significant graduate degree programs in eleven disciplinary subject areas and in addition, its broad program in Environmental Science encourages the development of multidisciplinary graduate research in several study areas.

The diversity and depth of the graduate programs of the College reflect the work of its excellent faculty and their graduate student colleagues utilizing some of the most modern facilities and laboratories in the country. They maintain a long-standing tradition of academic and professional excellence.

This bulletin provides an introduction to the College and its programs of graduate study and research. It only begins to suggest the diversity and depth of the exisiting and potential programs that make environmental science the *challenge of the 70's.*



Requirements for Degrees

Graduate programs are flexible and developed individually. Each program is planned by the major professor with the student to meet the individual's particular academic and professional needs. Sometimes this includes undergraduate courses for which no graduate credit can be given. In every case, emphasis is placed on outlining a study program leading to a high level of scholarly achievement.

An entire program for each student is planned and must be approved by the major professor, department chairman and School Dean. The program is modified as required upon recommendation of the major professor. A thesis committee composed of the major professor and two other faculty members is appointed early in each student's study program. In some departments, all graduate students are required to engage in an appropriate teaching assignment as an academic degree requirement.

THE MASTER'S DEGREE

All programs leading to the Master of Science (MS), Master of Forestry (MF) and Master of Landscape Architecture (MLA) degrees require at least 30 semester hours of graduate credit and two semesters in residence. From 6 to 18 hours of graduate credit may be earned through completion of a thesis or special project. The remaining credit hours are earned through completion of course work (passed with an average grade of B, or better). A total of at least 15 hours of credit, including thesis and special project credits, must be in courses numbered at the 600 level or above.

Acceptance of the thesis or special project depends on clear demonstration of ability to search and evaluate pertinent literature independently, to plan and carry through independent and important investigation, to interpret the significance of findings, and to present the subject in a well-organized, lucid and scholarly thesis. The student must also pass a final oral examination in thesis defense and demonstration of knowledge or related subject areas.

THE DOCTORAL DEGREE

Quality of work is especially emphasized for the doctor of philosophy degree. The student is required to penetrate the frontier of knowledge in the particular field of study and make a definite contribution to this knowledge. The student is also required to demonstrate original scholarship of a high order in the search and evaluation of literature, in the planning, execution and interpretation of scholarly research, and in the presentation of the findings in a thesis. Subsequent publication in a scholarly journal is expected.

There is no minimum credit hour requirement for the Ph.D. Each student must pass a qualifying examination before being admitted to candidacy. This two-part examination consists of a preliminary examination taken early in the period or residence to assist in planning a course work and independent study program, and a written and oral comprehensive examination to test breadth and depth of knowledge. There is no College-wide language requirement. However, competence in a foreign language, statistics, computer programming or other "tools" may be required where they are relevant to the student's field of study. A candidate for the Ph.D. degree with only a bachelor degree must be in residence for at least two full academic years. A candidate having a master's degree must be in residence for at least one full academic year. The final requirement is the presentation and defense of the Ph.D. thesis or dissertation which must represent an original contribution to knowledge.

Admission

REQUIREMENTS

Admission to graduate study may be granted only to applicants with at least a bachelor's degree from a recognized institution, and whose preparation has been suitable in quality and content for the proposed field of major study. Applicants will be evaluated on the basis of the following: (1) their academic record should show at least a B or 80 percent average for the junior and senior years; (2) Graduate Record Examination Aptitude scores, and, in some cases, subject matter (advanced) tests indicative of graduate study ability (see below); (3) supporting letters of recommendation; (4) a statement of specific educational and professional goals which describes the choice of degree program and the students' plan for the pursuit of the objectives in the program; and (5) where appropriate, other evidence of scholarly achievement and potential. Admission is selective with priority given to applicants who have high scholastic standing.

ADVANCED TESTS

Subject matter (advanced) test scores are required by the following programs:

Graduate Programs	*Advanced Test*
Chemistry	Chemistry
Forest Botany and Pathology	Biology
Forest Entomology	Biology
Forest Zoology	Biology

PROCEDURE

All applicants are required to submit Graduate Record Examination aptitude scores. This examination is offered several times each year in major cities of the world. For information on registration and scheduling write to the Educational Testing Service, Princeton, New Jersey 08540. Test scores should be sent to the Office of Graduate and Instructional Affairs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210 (Institutional number R2530).

The College provides a special form for application for graduate work. Requests for information and applications should be addressed to the Office of Graduate and Instructional Affairs, State University of New York College of Environmental Science and Forestry, Syracuse, new York 13210.

INTERNATIONAL STUDENTS

Citizens of other countries with special educational objectives are accepted for graduate study in all programs. They must show satisfactory evidence that they have completed studies in their major field equivalent to those at a recognized American institution with a scholastic record equivalent to a B average in their junior and senior years. They must submit Graduate Record Examination scores as explained in the section on Admission Requirements. Also, applicants whose native language is other than English must submit scores on the Test of English as a Foreign Language (TOEFL). This requirement may be waived if the student has received a degree from an American institution. This examination is offered several times each year in major cities of the world. For information on registration and scheduling, write to the Educational Testing Service, Princeton, New Jersey 08540, U.S.A. In submitting test scores, request that they be sent to the Office of Graduate and Instructional Affairs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

Expenses

TUITION AND FEES

The tuition and fee structure at the College includes library, health, infirmary, physical education, special testing and other services, as well as an assessment for student activities and charges for expendable supplies and equipment.

Graduate tuition for New York State residents is $600 per semester. Nonresident tuition is $750 per semester. All graduate students pay activity fees of approximately $28 per year.

COMMENCEMENT FEE

Candidates for a master's degree pay a commencement fee of $35. Doctoral candidates pay $65.

HOUSING

The College does not operate student residences. These facilities are offered by Syracuse University. Furnished and unfurnished apartments for single graduate students and for married graduate students and their families are located on the South Campus, approximately two miles from the Main Campus, and are serviced by a regular shuttle-bus.

Any student who wishes to live in Syracuse University housing should write to the Director, Married Students' Housing, 1528 East Colvin Street, Syracuse, New York 13210. Formal admission to graduate study is required before such requests are acted upon.

In addition, a wide variety of living arrangements in private homes and apartment complexes is available in the metropolitan Syracuse area.

OTHER COSTS

All graduate students are required to have health and accident insurance. Graduate fellows funded through the State University Research Foundation are required to take the health and accident insurance available through the Foundation.

The costs of textbooks and supplies may average $125 or more a year.

Financial Assistance

The College awards a substantial number of assistantships, fellowships and scholarships to qualified graduate students each year. The number of students receiving these awards varies from year to year, but usually more than half of all graduate students have received such support. In many cases it is not possible to provide a stipend at the start of the graduate study period, but such support is often provided after the student has demonstrated his competence.

Students may indicate their interest in a type of financial assistance on the last page of the graduate application form. Students on fellowships or assistantships must devote full-time to graduate study. Students seeking financial assistance should be sure their application and supporting documents reach the Office of Graduate and Instructional Affairs before March 1, to ensure full consideration for an award for the fall semester.

GRADUATE ASSISTANTSHIPS

Assistantships are awarded to students of demonstrated scholarship and whose education and experience enables them to assist in laboratory instruction and research. The amount of the assistantships is approximately $3,600 per year. In addition, tuition may be waived. Students on assistantships must carry 12 credit hours of course work, including research, per semester.

SPECIAL FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships and assistantships sponsored by industries, associations and foundations are available in several departments. The amount of stipends varies. Holders of these special fellowships and assistantships are required to confine the major part of their research activities to specified fields. Tuition is usually waived or provided by sponsors.

TUITION WAIVER SCHOLARSHIPS FOR INTERNATIONAL STUDENTS

Tuition waivers may be awarded to a limited number of international students judged to possess special academic capabilities and with demonstrated financial need, who are prepared to contribute to furthering international understanding and good will. Requests for such tuition waivers may be made on the last page of the graduate application forms.

TUITION ASSISTANCE PROGRAM

Qualified New York State residents are eligible for Tuition Assistance Program grants and State University Grants-in-Aid which vary with the net taxable family income of students, and the level of study, and provide substantial reductions in tuition. For details, contact the Coordinator of Financial Aid at the College.

LOANS

Graduate students may be eligible for various types of educational loans. The New York Higher Education Assistance Corporation offers

loans to residents which are interest free until after college, and then charges seven percent annual interest under current regulation. Repayment terms are arranged after graduation.

A graduate student who is a U.S. citizen may borrow up to $2,500 a year under the Student Loan Program of the National Defense Education Act of 1958. No interest will accrue until nine months after leaving college, and then it is at three percent. Part of the loan will be canceled if the student becomes a public school teacher or college teacher or enters military service. A ten-year repayment period is allowed.

OTHER FORMS OF SELF SUPPORT

Many graduate students support their studies through part-time employment at the College in laboratories and other College activities. Employment may also be sought outside the College on a part-time basis. Contact the Coordinator of Placement for details and availability.

The College also participates in the Federal Work-Study Program which is designed to enable students to partially defray their educational expenses through part-time jobs during the academic year. Applications and further information are available from the College's Office of Financial Aid.

Graduate Degree Programs

SCHOOL OF ADVANCED ENVIRONMENTAL SCIENCE

Environmental Science

The environmental problems facing the world today are a complex product of man's interaction with his environment, not a simple sequence of technological difficulties. They derive from a dynamic interaction of scientific, technological, design and managerial factors having economic, political and legal ramifications.

The graduate program in environmental science is an integrated, interdisciplinary scheme of course work and research unique to each student. It is designed to help the student develop a basic focus in one aspect of the environmental complex while developing a cognizance of other interrelated elements. The research components of the program encourages individual accomplishment and brings together students from diverse backgrounds in teams or task forces to research a particular environmental problem. Students bring to the task expertise in science, planning, management, design or engineering, and each learns to relate one's common problem. In the process each develops insights through study of the social, legal, political and communications factors that are integral parts of the total problem. The student develops an enhanced understanding of environmental problems and valuable experience in seeking their solution.

The program is designed to be flexible in nature, and it enables the student to apply prior academic training in a discipline to the solution of an environmental problem, while developing additional training with broader implications. Other important inputs to the program are the resources of Syracuse University in the course work areas of communications, policy, law, sociology and political science, all of which have become important in today's understanding of man's interaction with his environment.

The program in environmental science draws upon and involves faculty, course work, facilities and philosophies of all the disciplinary degree programs which are described in the next few pages. The relevant pieces of these programs and the strength of them provide the necessary disciplinary support to make the concept of "interdisciplinary program" a viable entity.

SCHOOL OF BIOLOGY, CHEMISTRY AND ECOLOGY

STUART W. TANENBAUM, *Dean* (Microbial Ecology and Metabolism); MICHAEL FLASHNER (Enzymology)

Botany and Forest Pathology

TEPPER, *Chairman* (Anatomy and Morphogenesis); AMES (Morphogenesis); GEIS (Ecology); GRIFFIN (Mycology and Fungus Physiology); KETCHLEDGE (Ecology and Bryology); MANION (Pathology); McDOWELL (Fungus Physiology); SCHAEDLE (Physiology); SILVERBORG (Pathology); VALENTINE (Genetics); WANG (Mycology); WILCOX (Physiology of Growth and Development); ZABEL (Wood Deterioration)

The program in botany and pathology is designed to provide students with graduate level instruction in basic botanical and related natural and physical sciences. Research and thesis problems are generally designed to utilize forest organisms in the development of biological knowledge. Opportunities for graduate study within the program are offered in the fields of anatomy, morphogenesis, physiology-biochemistry, ecology, forest pathology, wood deterioration, mycology, genetics and taxonomy. Courses in climatology, meteorology, soils, ecology, bacteriology, botany, microbiology, genetics, mathematics, chemistry and statistics, all available in other departments at the College and at Syracuse University, provide additional support for the program.

Current areas of active research by departmental faculty are: *anatomy and morphogenesis*—factors that influence the development and form of root systems and regulate the development of root and shoot apices, cell differentiation in tissue culture; *physiology*—chemical regulation of organ growth, the nature and physiology of mycorrhizae, ion transport, mineral nutrition, biochemical aspects of cambial physiology, photosynthesis; *ecology*—dynamics of plant communities in the Adirondack Mountain Region and on the Allegheny Plateau, the influence of man on plant communities, the interaction of environmental factors during vegetational change, phytogeography and chemical ecology; *forest pathology*—disease of forest plantations, heart rots and cankers, tree rusts and physiogenic diseases; *wood deterioration*—the effects of stains and decays on wood use and their controls, the chemistry of wood decay, toxicity mechanisms and the bio-assay of toxicants; *mycology*—the taxonomy, sexuality, and morphology principally of wood-inhabiting fungi and microfungi; *fungus physiology*—the role of nucleic acids and intermediary metabolism in growth and morphogenesis; *genetics*—quantitative and population genetics, the heritability and natural variations in wood characteristics that are important in forest products and wood pulp; *taxonomy*—the identification, nomenclature and classification principally of fungi, bryophytes and vascular plants.

Illick Hall, the biological science building, provides faculty and students with modern facilities for botanical research. Special facilities include rooftop greenhouses, growth chambers, herbaria and special research laboratories for tissue culture, microchemistry, microtechnique, microscopy, radiochemistry, chromatography and computation. In addition, a cobalt-60 source, electron microscopy laboratory and a computer center are available at the College for student use. Extensive College forests, including most forest types of the Northeast, plantations and nurseries, offer exceptional opportunities for field study of forest plants and diseases.

Research in botany and forest pathology is supported by private industry, the U.S. Forest Service, the New York State Department of Environmental Conservation, the Research Foundation of the State of New York, a variety of Federal agencies and by the State of New York. In addition to direct project support, the grantees also provide for graduate research assistantships.

Entomology

SIMEONE, *Chairman* (Ecology and Wood-Inhabiting Insects); ALLEN (Ecology and Population Dynamics); BREZNER (Physiology); CAMPBELL (Population Dynamics); KURCZEWSKI (Morphology, Taxonomy, Behavior); LANIER (Ecology, Cytotaxonomy); MORRIS (Medical Entomology); NAKATSUGAWA (Toxicology)

Opportunities for graduate study in entomology are available to students with interests in both basic and applied aspects of insect-related problems. On-going research includes classical biological studies of forest insects and those causing the deterioration of wood, as well as diverse areas such as host-parasite relationships, host selectivity, population dynamics, insect physiology, dehydrogenases, mechanisms and enzymology of insecticide detoxification, biochemical systematics, comparative behavior, insect communications, taxonomy, histology and cytology and medical entomology. Selected problems may also concern the economic impact of forest insects as well as chemical, biological and silvicultural aspects of insect control.

Interdisciplinary pursuits are encouraged in chemical ecology, genetics, forest pathology, vertebrate entomology, immunology and climatology involving other departments at the College, Syracuse University, and nearby Upstate Medical Center of State University of New York. Areas of specialization are enhanced by supporting courses in these other disciplines. Students interested in insect ecology, chemical ecology, physiology or taxonomy, for example, may pursue these subjects relative to plants and other animals by selecting courses in botany, silviculture, zoology, biochemistry and applied mathematics.

Students and faculty have a wide range of field and laboratory facilities available for research. The several forest properties represent varied forest environments, while Illick Hall provides modern controlled facilities and instrumentation. More than 18,000 square feet of indoor space is available, with access to an electron microscopy laboratory and scanning electron microscopes, environmental chambers, ultracentrifuges, nuclear magnetic resonance equipment, gas chromatograph, isotope laboratory, a cobalt source for irradiation, a soundproof room, glasshouses and an insectary complex affording subjection of insects to controlled as well as ambient weather conditions. The taxonomic museum houses nearly 100,000 insect species deposited by entomologists for more than half a century. A computer center provides services in all phases of entomological research.

Forest Zoology

ALEXANDER, *Chairman* (Vertebrate and Wetland Ecology); BEHREND (Wildlife Ecology and Management); BROCKE (Bioenergetics and Wildlife Ecology); CHAMBERS (Wildlife Ecology and Management); DINDAL (Invertebrate Ecology); GRAVES (Physiological Ecology); HARTENSTEIN (Invertebrate Physiology); PAYNE (Wildlife Conservation); PRICE (Animal Behavior); TIERSON (Wildlife Conservation); VanDRUFF (Vertebrate Zoology and Wildlife Ecology); WERNER (Limnology and Aquatic Ecology); MULLER-SCHWARTZ (Animal Behavior and Chemical Ecology)

Graduate studies in zoology include both basic and applied research on animals of our natural ecosystems, including their associated soils and water. Programs are offered in vertebrate ecology, soil invertebrate ecology, physiology, population ecology, animal behavior, forest wildlife biology, aquatic ecology, forest wildlife management and fishery biology.

Many of the faculty and students are located in Illick Hall, the biological sciences building. Facilities include specialized laboratories for research in physiology, soil invertebrate ecology, animal behavior, aquatic biology

and wildlife biology. An extensive collection of invertebrates is available, as well as the large Roosevelt Wildlife Collection. Various temperature-humidity chambers are available, including an environmental simulating chamber which programs and records light, temperature, humidity, altitude, wind and precipitation.

Graduate students may participate in an intensive research program in wildlife biology at the Archer and Anna Huntington Wildlife Forest, a 15,000-acre forest in the Central Adirondack Mountain region. Many forest types are present in varying stages of management. Four faculty members are year-round residents.

Field research may also be conducted at the College's Heiberg Memorial Forest and Experiment Station. Several other areas are located within a 35-mile radius of Syracuse, and frequently are used for research purposes. These include Onondaga County's Highland Forest; the Department of Environmental Conservation's wildlife management areas—Tioughnioga, Three Rivers, Howland Island and Cicero; the Montezuma National Wildlife Refuge; and privately-owned lands. A wide variety of ponds, streams and lakes in Central New York are regularly used by graduate students in aquatic ecology and fishery biology. Also, various forests, fields, aquatic areas and waste beds are used for invertebrate investigations.

These facilities and areas are supplemented by the services and facilities of the College's other departments, particularly the departments of botany and forest pathology, and entomology. The School of Environmental and Resource Management provides support in relating the managerial and silvicultural facets of forest resources to animal ecology and wildlife study programs. The College is adjacent to Syracuse University with its large department of biology, strong in physiology and developmental zoology. Available through this institution are programs in social sciences and engineering, including land use and environmental pollution.

The State University Upstate Medical Center also is nearby. Its facilities are available for graduate students whose research can benefit from the specialized library, equipment and faculty.

Examples of recent research include the ecology of forest wildlife species, movements of larval fish, domestication of Norway rats, waterfowl marsh ecology, wetland planning, nesting behavior, deer behavior, physiology of isopods, pesticides and soil fauna, physiology of hibernation and the population dynamics of deer.

Chemistry (Polymers, Natural Products, Biochemistry)

SMITH, *Chairman* (Physical and Polymer Chemistry); LaLONDE (Organic and Natural Products Chemistry); SARKO (Physical and Polymer Chemistry); SCHUERCH (Wood and Polymer Chemistry); SILVERSTEIN (Ecological Chemistry); SMID (Physical and Polymer Chemistry); SZWARC (Physical and Polymer Chemistry); TANENBAUM (Microbial Chemistry); TIMELL (Wood Chemistry); WALTON (Biochemistry)

Recent years have seen profound advances in the fundamental knowledge of chemical areas which have special significance for forestry and the environment. The following research areas have received active attention by both faculty and graduate students in the programs: polymer chemistry and physics, wood chemistry, biochemistry, chemistry of natural products including ecological chemistry, and organic materials sciences. (See also Interdisciplinary Program in Organic Materials Science.)

Requirements for a master of science or doctor of philosophy degree in chemistry include a research project and thesis, along with an appropriate program of courses at the College and at Syracuse University.

Specific projects may vary from year to year, since they reflect the current interests of the faculty. Current research projects with *physicochemical* emphasis are: the chemistry, physics, solid state and solution properties of natural and synthetic polymers, including studies in thermodynamics, statistical mechanics, crystallization, morphology, elasticity, conformation of macromolecules, optical properties, polymer catalysis, mechanism of polymerizations, polyelectrolytes, ion binding to macromolecules and ion pairing; chemistry of free radicals, radical ions and charge transfer processes; structure and properties of ionic solutions in nonaqueous media; crystal structure and morphology of cell wall constituents. Current *organic* chemistry programs deal with synthesis of special polymers such as high temperature aromatic block, stereoregular vinyl polymers, and polysaccharides, various aspects of natural products chemistry, but especially alkaloids and terpenes, isolation and characterization of insect and mammalian attractants. An active program on the structure and topochemistry of the *polymeric* wood components, hemicelluloses, lignins and celluloses is underway. In *biochemistry*, department members are studying mechanisms of action of plant growth hormones, biochemical regulation of seed germination, plant enzymology and ultrastructural plant cytology.

SCHOOL OF ENVIRONMENTAL AND RESOURCE ENGINEERING

ROBERT V. JELINEK, *Dean* (Computer Applications, Process Engineering, Corrosion)

Graduate studies and related research activities in the School of Environmental and Resource Engineering are concerned with optimum development and utilization of natural resources, including structure, properties and manufacture of solid and composite wood products, paper and related fibrous materials. Program elements include various aspects of site evaluation and enhancement, unit and system design, production and processing and qualitative and quantitative measurement and computation. Environmental conservation and pollution abatement are stressed.

In addition to the three formal degree programs in *Forest Engineering, Paper Science and Engineering* and *Wood Products Engineering*, the School faculty has recognized the need for a new program to synthesize the inherent strengths of each of these in an engineering systems approach. This program in *Production Systems Engineering*, currently offered on an experimental basis at the master's level, enables students with various engineering or science backgrounds to acquire an integrated view of production processes, stressing the whole production system and focusing upon interfaces among subsystems. For each student in this program, an individualized plan of regular courses and special studies is designed, centering on a thesis project in production system analysis or design. A similar program in *Environmental Systems Engineering* is under development.

Graduate research laboratories in the Hugh P. Baker Laboratory are well equipped for polymer studies, chemical and biochemical research. Instrumentation includes analytical and preparative ultracentrifuges, Warburg respirometer, recording infrared and ultraviolet spectrophotometers, mass spectrometer, differential refractometer, electron spin resonance spectrometer, nuclear magnetic resonance spectrometer, automatic membrane osmometers, solid and solution state light scattering photometers, recording polarimeter and optical dispersion spectrometer, several ultramicrotomes, electron microscopes, X-ray diffraction, instrumentation chromatography and cold laboratories, and radiochemical laboratories with counters for solids, liquids and gases.

Forest Engineering

TULLY, *Chairman* (Structures, Water Resources, Soil Mechanics); BENDER (Geodesy, Photogrammetry, Land Data Systems); BROCK (Analytical and Interpretive Photogrammetry, Remote Sensing); LEE (Systems Engineering, Computers, Soil Mechanics); LILLESAND (Remote Sensing, Environmental Monitoring and Transportation); PALMER (Harvesting, Systems Engineering)

The forest engineering program is primarily concerned with engineering analysis and design in concert with other pertinent disciplines for the holistic development of the natural resources associated with the forest environment. The program objective is to support the discipline by producing graduates with sufficient understanding of the forest environment and its resources, of the methodologies of scientific research, and of the principles of engineering analysis or design to work with competence in resource-related research, engineering design and management.

Individually designed programs leading to the master of science and doctor of philosophy degrees are available. Undergraduate backgrounds required depend upon the student's needs and interests in graduate study. The student may emphasize engineering measurements, analysis or design within the program's breadth of engineering concern for environmental influences and resource utilization. Successful programs of graduate study in forest engineering may be efficiently designed by students with bachelor of science degrees in engineering or in forestry, natural sciences, physics or mathematics.

Programs of emphasis on environmental engineering measurements may be designed in remote sensing, photo interpretation, geodetic engineering, analytical photogrammetry and photogrammetric systems. Programs emphasizing engineering analysis and design are available in water resource, transportation, harvesting and site engineering systems. Included are the monitoring, measurement and evaluation of physical parameters affecting water, soil, timber, vegetation and wildlife.

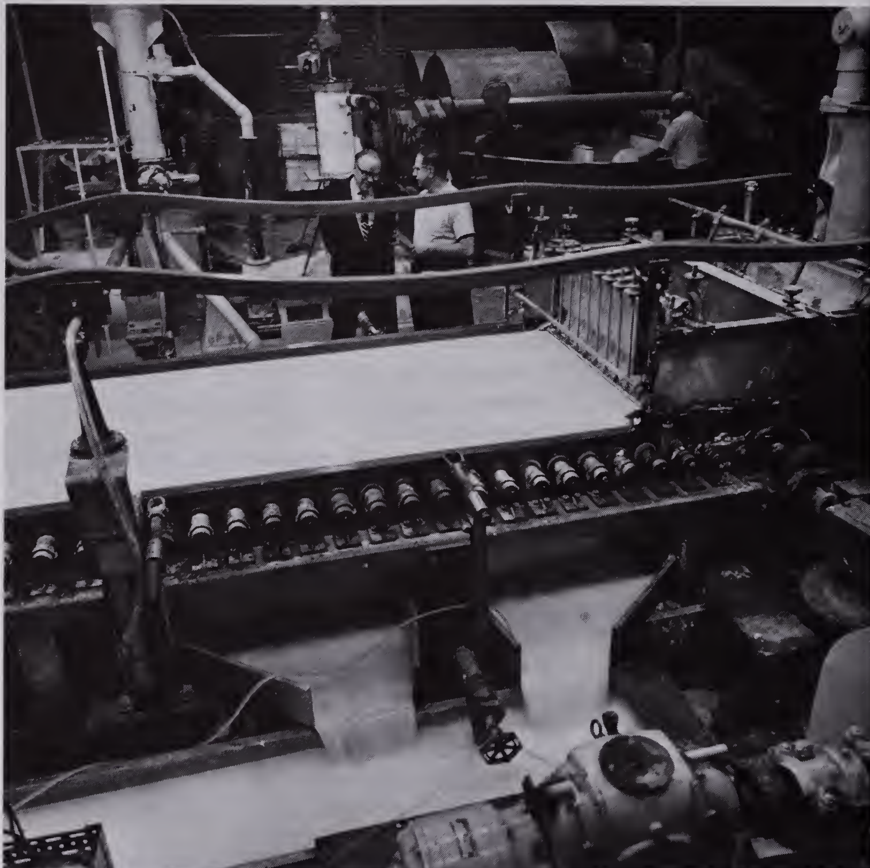
Support for the forest engineering graduate program is both internal and external. The internal support includes modern laboratory and instrumentation facilities in the Engineering Schools at both the College and Syracuse University. Exceptional departmental support exists for programs in environmental engineering measurements in the form of photogrammetric laboratories and the extensive forest properties owned by the College at which research may be conducted.

External support for the program comes from several active sources, including industrial, commercial and governmental. Over the past two decades, close cooperation has developed special study and research opportunities with these sources.

Paper Science and Engineering

BAMBACHT (Pulping, Papermaking, Water Quality); DENCE (Organic Chemistry and Lignin Reactions); GORBATSEVICH (Pulping, Bleaching, Paper Technology and Paper Properties); LEOPOLD (Organic Chemistry and Mechanical Properties of Fibers and Paper); LUNER (Mechanical and Surface Properties of Fibers, Films and Paper); MARK (Fiber Physics); MARTON (Paper Properties, Microscopy and Pulping); STENUF (Chemical Engineering, Instrumentation, Thermodynamics, Process Control, Metallurgy and Corrosion)

Outstanding for its vigorous growth and diversity of products, the pulp and paper industry is the fifth largest in the nation and exceptionally strong worldwide. The need for professional men and women with



advanced education in science, engineering and technology is increasing even more rapidly than the industry itself. The College pioneered in providing graduate study in this area in 1920 with the organization of the paper science and engineering program.

Since its inception, the program has maintained a singularly high position in professional education for the continuing development of the pulp, paper and allied industries. Its graduates, who are in constant demand, occupy positions of leadership throughout the world.

The graduate program reflects the strong trend toward diversification in the industry and offers opportunities for obtaining master of science and doctor of philosophy degrees in a variety of subjects related to the manufacture of pulp and paper. Advanced courses are offered in such diverse chemistry, paper physics and fiber morphology, as well as specific areas of pulping and paper properties.

Walters Hall, opened in 1969, is devoted exclusively to education and research in this field. Containing a large number of special purpose laboratories and highly sophisticated equipment, it houses one of the outstanding research facilities in the world, the Empire State Paper Research Institute.

Research activities aim to generate new information regarding the fundamentals, the science, the engineering and the technology of the papermaking process, utilizing advanced techniques such as electron microscopy, specialized spectrophotometry, nuclear magnetic and electron spin resonance and nuclear tracer methods. Also included is a modern chemical engineering laboratory, designed for studies in all phases of unit operations and processes, process control, thermodynamics and analog simulation.

The program maintains an experimental pulp and paper mill equipped with machinery and instrumentation for studies of pulping, pulp purification, reuse of secondary fibers, refining, paper additives and papermaking. This facility includes a paper machine, a 400 horsepower double-disk refiner, a two-pocket grinder for mechanical pulping and auxiliary equipment. Recent work has been directed to fundamental investigations of pulping, bleaching, additives, recovery of secondary fibers, the papermaking process, reactions of wood components during mechanical and chemical treatments, evaporation, fluid dynamics, heat transfer, the structure of wood and wood fibers and chemical and fiber recovery.

Wood Products Engineering

DAVIDSON, *Chairman* (Organic Materials Science); COTE (Cellular Ultra-structure); DeZEEUW (Wood Anatomy, Structure-Property Relations); KYANKA (Applied Mechanics-Structures); MEYER (Wood-Polymer Systems, Radio-Isotope Techniques); MOORE (Bonded Materials Technology); PENTONEY (Mechanical Behavior, Fracture Mechanics); SIAU (Protective Treatments, Transport Processes); SKAAR (Wood Physics); G. SMITH (Materials Marketing); L. SMITH (Polymeric Adhesives and Coatings); WHITT (Industrial Engineering)

While wood is one of the oldest structural materials known to man, its economic importance today is reflected in the fact that the annual tonnage of wood produced in the United States far exceeds that of any of the other major structural materials. This fact becomes even more important in this age of environmental and ecological concern because wood is the only major structural material that comes from a renewable natural resource, and demand is growing for more efficient utilization of available material. Improved efficiency must be based on solid scientific and engineering information. Thus research projects aimed at providing such information form the basis of the graduate program in wood products engineering. The major areas of specialization are: wood science, wood products engineering (with emphasis on either structures or production systems) and product distribution systems.

Basic degree requirements for either a master of science or a doctor of philosophy degree include appropriate course work, which prepares the

student to undertake a research project culminating in the writing of a thesis.

Recent research projects in wood ultrastructure have dealt with the interaction of coatings and glues with the wood substrate, cell wall development, the effectiveness of wood preservatives and the identification of natural inclusions in wood. The field of wood physics has had active projects in the permeability of wood, the mechanisms of fluid transport and the mechanisms of electric charge transport. Current projects are underway in the mechanical behavior of fiber networks, fracture mechanics of wood and the behavior of new structural designs which represent interests in the field of mechanics. In addition, there is a newly emerging field dealing with the properties of wood-based composite materials.

The laboratory facilities of the program include a modern mechanics laboratory which has a range of mechanical testing machines, a well-equipped physics laboratory with various electronic instrumentation, complete wood processing facilities including a sawmill and veneer mill, and an extensive foreign wood collection. In addition, the College has available a complete microscopy laboratory, containing both scanning and transmission electron microscopes and a wide variety of light microscopes and related equipment. Extensive equipment for chemical analysis and nuclear chemical techniques serve the College's research program.

SCHOOL OF ENVIRONMENTAL AND RESOURCE MANAGEMENT

CHARLES C. LARSON, *Dean* (Resource Policy and Administration, International Forestry)

Department of Managerial and Social Sciences *

ARMSTRONG, *Chairman* (Industrial Economics, Resource and Market Analysis); BENNETT (Economic Theory, Economic Thought in Forestry); CANHAM (Regional Economics and Planning); CHRISTIANSEN (Forest Production Economics, Economic Systems Analysis); CUNIA (Operations Research, Statistics, Mensuration); GRATZER (Forest Recreation, Resource Management); HANSELMAN (Educational Communications); KOTEN (Management, Systems Analysis); MORRISON (Sociology of Outdoor Recreation); MUNIAK (Environmental and Resource Administration and Politics, Policy Planning); PETRICEKS (Macroeconomics, International Forestry Economics; STITELER (Biometry, Experimental Design, Computer Analysis)

Department of Policy and Program Affairs *

DALL (Environmental Policy and Law); GRAVES (Resource Policy, Planning Management); HENNIGAN (Resource Policy, Management); HORN (Law, Business Management)

Department of Silviculture and Forest Influences

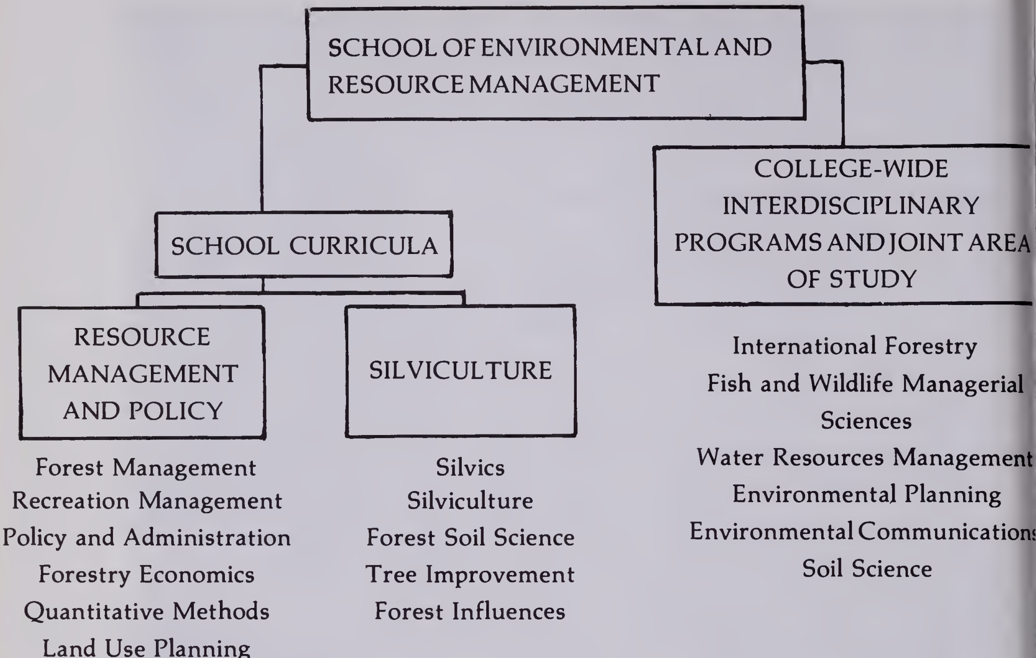
JOHNSON, *Chairman* (Silviculture); BERGLUND (Silvics); BLACK (Watershed Management); CRAUL (Forest Soil Science); ESCHNER (Forest Influences); HERRINGTON (Meteorology); LEA (Silviculture); LEAF (Forest Soil Science); RICHARDS (Silviculture, Environmental Science); WESTFALL (Physiology-genetics, Tree Improvement)

Adjunct Faculty

CHRISTENSEN (Forestry Economics and Policy); DUERR (Managerial Economics, Resource and Market Analysis); ECHELBERGER (Forest Recreation Research); HEISLER (Meteorology); MINCKLER (Hardwood Silviculture); MOELLER (Forest Recreation Research); WILLIAMS (Forest Taxation).

Faculty of the School of Environmental and Resource Management support two types of programs at the graduate level. As shown in the figure below, disciplinary education is offered in two broad curricula: Resource Management and Policy and Silviculture. Strong input also is made to College-wide interdisciplinary programs and joint areas of study, particularly in the areas of International Forestry, Fish and

* Effective September 1, 1975, these two Departments were consolidated into a single Department of Managerial Science and Policy.



Wildlife Managerial Science, Water Resources Management, Environmental Planning, Environmental Communications and Soil Sciences.

Several areas of specialization are available within the disciplinary curricula, as shown. But opportunity is also provided for students, in consultation with faculty advisors, to arrange areas of study specific to their interests and needs which integrate elements of two or more areas of specialization. Whatever the program, the basic purpose is to help the student acquire the tools and facility for disciplined, logical, critical, constructive and creative thinking, and for clear expression in the selected field.

Prospective students who desire more information than is presented in this catalog, for each of the graduate curricula and specialities shown in the diagram, should contact the Office of the Dean, School of Environmental and Resource Management.

Resource Management and Policy

Today's successful resource manager is one who can anticipate and prevent environmental troubles as well as attempt to remedy them; who is equipped not only to make current institutions function effectively but also to create new ones better fitted to changing social needs; and who can bring the strengths of many disciplines to bear on vexing environmental problems.

The resource management and policy curriculum has been designed to meet the need for capable managers by requiring broad acquaintance with several fields, by developing strong integrative facility and long planning horizons, and by encouraging team attack on complex problems.

Specialized areas in *forest management, recreation management, policy and administration, forest economics, quantitative methods* and *land use planning*, are described below. Depth in each area is balanced by required understanding of both the physical-biological and the social systems which merge to form the context for wise resource development. Integration of fields is gained through study of current issues and application of managerial tools to real-world conditions. In all specialties, focus is on the goals of management, on advanced techniques for meeting them and on current and prospective issues and how to attack them. The rich resources of the College's other Schools and of Syracuse University are drawn upon freely in support of program efforts.

Forest Management

The forest management area focuses on the planning and implementation processes necessary to achieve integrated use of forests and related resources. The objective is to develop expertise sufficient for capable, professional resource management to satisfy a wide range of societal needs.

Broad knowledge of the operation of both biological and social systems is combined with skill in the use of managerial tools. Concepts in decision theory, and information and organization theory, particularly, are applied to representative cases at varying levels of complexity. Syracuse University's School of Management and Maxwell School of Public Affairs offer a broad array of support courses. Students prepare themselves for any of a wide range of positions in research, program analysis, teaching, administration, budgeting and other phases of forest resource management with federal and state agencies and private firms.

Quantitative Methods

Study in the area of quantitative methods is designed to develop professionals skilled in mathematical and statistical problem solution and equipped to act as biometricians, mensurationists or in similar posts, with state and federal agencies and with private firms.

The program is designed primarily for students who have done their undergraduate work in areas such as biological sciences, forestry, wildlife or agriculture. Others, who lack background courses, may take this material concurrently. Students may concentrate in statistics, operations research, biometry, or forest mensuration. Syracuse University's IBM 370 computer, programming banks and a wide range of courses in mathematics, statistics and quantitative methods give strong support to the program.

Land Use Planning

Graduate study in land use planning aims to show how development and utilization of the land resource affects and is affected by natural and social systems. It provides basic understanding of the tools and processes of regional planning and addresses land use policy issues. Student programs are flexible and draw heavily from course offerings in resource economics, resource policy and administration, open space planning, and applied ecology. In addition, the rich course offerings of other Schools and Syracuse University in such areas as remote sensing, geography and metropolitan studies are available. Some undergraduate work in the natural and social sciences is required.

Employers normally include county, regional and state planning commissions; federal agencies such as the Forest Service; and private consulting firms. Consultation from these sources is encouraged in graduate theses and research, and in the conduct of seminars.

Recreation Management

Graduate study in this area equips students with broad understanding of the nature and purposes of outdoor recreation and how it relates to natural resources, and builds the skills necessary for capable recreation management.

Individual programs combine study in resources management with relevant studies in the social sciences and development of analytical and political capabilities needed to implement plans and programs. The U.S. Forest Service Research Unit, situated on campus, provides strong support for research and independent study. Other schools of the College and of Syracuse University, treating such areas as planning, engineering, design and education, provide a wide range of supporting courses and facilities.

Graduates find employment in resource management agencies administering recreation areas; in national, state and local parks and recreation departments; in educational institutions and in private organizations involved in recreation.

Policy and Administration

Graduate study in the area of policy and administration prepares students for the broad range of responsibilities comprising the field of program administration in a public agency or a business at the executive, planning, budgeting, programming or operating levels. Advanced courses, special problems and seminars structured around man-resources relationships, resources policy issues, administrative management, and environmental law are offered.

Students are encouraged to round out their academic programs through the offerings of other units of the College as well as the Syracuse University Maxwell Graduate School of Citizenship and Public Affairs and the School of Management.

The wide-ranging possibilities of course selection and the differing points of view that are available allow the student to tailor a program to meet specific career objectives. This breadth and diversity also offers the student an opportunity to develop talents for top executive leadership in various aspects of a field that is critical to the future of resource management.

Forest Economics

In this area, study at the master's level is designed to meet the needs of the graduate in forestry or forest products. It also serves the graduate in liberal arts, engineering or business whose interests point toward the economics of forest resource management. The aim is primarily to broaden the student's understanding of the content of forestry economics.

The Ph.D. program is for those who wish to make a career as professional forestry economists in research institutions, in the academic world, or in business or government. The goals are depth of understanding and familiarity with economic tools contributory to making competent decisions in resource economics, management and policy. Requirements are generally the same as those observed in economics departments of leading universities, except that the student completes specified work in the economics of forestry.

Individual programs may include supporting courses in general economics, mathematics and statistics, operations research, business, international affairs and other social sciences and related fields. The broad array of course offerings and substantial library resources, computer facilities and other resources of Syracuse University supplement those of the College.

SCHOOL OF LANDSCAPE ARCHITECTURE

BRADFORD G. SEARS, *Dean* (Natural Area Studies)

CURRY (Urban Analysis and Design); EARLE (Art and Design, History of Environmental Development); FELLEMAN (Site Engineering, Resource Policy Administration); FREEMAN (Plant Materials, Site Design); HARPER (Regional Environmental Planning); LEWIS (Community Planning, Systems Dynamics, Gaming Simulation); MACEY (Design Determinants, Environmental Impact Assessment, Design); NIEMAN (Regional Planning and Environmental Impact); PAULO (Design, Environmental Law); POLLAK (Social Policy Planning and Analysis, Social Geography); REIMANN (Methods and Philosophy of Design); TRYON (Design Methods, Site Design)

Landscape Architecture

There has always been a need and a desire for man to adjust to his physical environment, or to modify it in order to meet his requirements for shelter, sustenance and communication. Society has reached the point in the latter half of the 20th century where economic and technological sophistication enables man to completely control the physical environment. It is within the balance between man and nature, and the manipulation of land as it relates to man's use, that the role of the landscape architect lies. The professional landscape architect is concerned with the quality of the condition and form of the physical/cultural landscape. Because of this concern, the landscape architect may work at any scale, from small site design projects with their related designed amenities, to the orchestration of regional, national or international projects which attempt to develop policy for qualitative use of land.

Landscape architecture is about land and people. The very dynamics of this relationship has lead to a profession which is always changing to keep abreast of man's needs.

The MLA degree program offers the opportunity to study advanced concepts and methods in landscape architecture. It is normally completed in two years. The curriculum has three aspects: a sequence of required core courses; a series of elected courses; and a terminal study.

Studio workshop courses, seminars and courses in methods and topics for environmental research form the required core sequence. The emphasis in these courses is on identification and definition of environmental problems, development of strategies for their solution and utilization of sophisticated methods and techniques in their resolution.

Complementary to the required courses, the degree candidate takes a series of elective courses normally chosen from the School, the College of Environmental Science and Forestry or Syracuse University. Each student orients the choice of elected courses according to personal educational objectives. The student may wish, for example, to specialize

in one or generalize in the many disciplines related to the needs of the professional landscape architect. Upon the approval of the faculty, a student also has the opportunity to take a part of the elected course work in self-described independent study.

Each MLA degree candidate completes the degree requirements by preparing a well-documented terminal study and satisfactorily defending the work in an oral examination. The terminal study is normally completed during the fourth semester of residence.

Research at the School, both sponsored and independent, has two major thrusts. The first is applied research. Here emphasis is to develop greater sophistication in contemporary methods and techniques used to solve real environmental problems. The second is original research, where the emphasis is to develop new data, criteria or methods which can be used in solution strategies for environmental problems.

The College library and the several libraries on the Syracuse University campus offer in-depth reference material to support study programs. Facilities at the School are extensive. They include adequate studio and office space as well as reproduction, model making, photographic and audio-visual equipment. The College maintains a computer center which is used primarily for instruction and is available for individual use by graduate students. The College also has a fully equipped video tape recording (VTR) studio and photogrammetric labs.

The School is unique in its location within the College of Environmental Science and Forestry. This situation provides the MLA candidate with the opportunity to draw upon information and knowledge in ecology, natural sciences, resource management, forestry and many other related environmental concerns. In addition, the relationship with Syracuse University provides the School with a wide-ranging human and physical resource base.

The Syracuse area has the largest concentration of landscape architectural firms in the State, outside of New York City. With a metropolitan population of nearly 500,000, the city has many opportunities for urban-oriented study. Also, the city's central location in upstate New York provides easy access to a rich variety of public lands and recreation areas which are planned and administered by a diverse range of governmental agencies and private owners.

Any student with a bachelor's degree, or the equivalent from a college or university of recognized standing, is welcome to apply for admission to the MLA degree program. Along with the general application requirements of the College, each applicant is encouraged to submit any examples of work, such as academic reports, terminal projects and portfolios of creative endeavors or design work.

INTERDISCIPLINARY PROGRAMS

Formal interdisciplinary programs leading to Master and Doctor of Philosophy degrees are available in the areas of *Organic Materials Science*, *Water Resources*, and *World Forestry*. These are described below.

Organic Materials Science

Organic Materials Science is that segment of the natural sciences that deals with the structure-property relationships in organic materials. For decades the College has been involved in various aspects of Organic Materials Science through programs in the sciences of paper, polymers and wood. An understanding of the behavior of materials in general has developed rapidly in recent years and it is now clear that many of the fundamental concepts of material properties are applicable to both natural and synthetic polymers. This thinking has led to the establishment of the new interdisciplinary program in Organic Materials Science. This program involves the Departments of Chemistry, Paper Science and Engineering, and Wood Products Engineering, the Empire State Research Institute, the Cellulose Research Institute, and the State University Polymer Research Center.

Organic Materials Science strives to instill in the student a broader perspective than is normally achieved in standard academic programs. This is accomplished by uniting the student's immediate research interests to larger goals involving several disciplines. In this manner a generalization of interest is acquired without sacrificing scientific rigor and depth of knowledge in more restrictive areas. Materials of current research activity include films, fibers, elastomers, composites, antithrombogenic materials, membranes, polyelectrolytes, polysalts, fiber assemblies, wood, paper, and wood-polymer systems, and involve studies in thermodynamics, statistical mechanics, chain conformation, crystallization, crystal morphology, X-ray, light scattering, polymerization, polymer reactions, wood and paper physics, elasticity, contractility, heat and mass transport, and paper properties. See also the sections of the participating departments and institutes.

Although graduate programs in Organic Materials Science are available at both the master and the doctoral level, it is expected that most students work for the doctoral degree. Programs consist of course work and research. Course work requirement is tailored to build upon the individual student's undergraduate background and experience. Entering students are expected to have a Bachelor's degree in chemistry, physics, engineering, polymer science, wood and paper science. The course work portion of the Organic Materials Science program will be directed toward background preparation in solid state and polymer science. Near the end of the student's course work program he will be exposed to the modern concepts of the structure-property relationships that are of importance in organic materials. Research topics will be selected to permit the student to explore in depth an aspect of organic materials in which he has a particular interest.

Students registering in the Organic Materials Science program satisfy all college-wide requirements for advanced degrees. Each student will be assigned a major professor and a faculty committee who will help him plan his course work program and who will serve as consultants on his research project. Courses will be selected from those offered, both at the College of Environmental Science and Forestry and the Colleges of Engineering and Liberal Arts at Syracuse University. The research work will be carried out in College of Environmental Science and Forestry laboratories which are particularly well equipped for materials science studies.

Water Resources

The College is concerned broadly with biological and managerial relationships of forest resources, and the productive uses and benefits of forest products and services. The College has particular interests in the ecological and biological relationships having to do with the management and utilization of water resources; with problems of water quality, quantity, and availability as these are related to land use and development activities; and with the special problems of the forest industries which utilize water in manufacturing processes or produce by-products which affect water quality. The rehabilitation, protection and improvement of watersheds is an important corollary area of interest.

Graduate study programs in water resources may be arranged on an informal basis within several departments of the College to include the disciplines of forestry economics, forest management, forest engineering, silviculture, landscape architecture, forest zoology, forest entomology, forest chemistry, and paper science and often involve support from several Colleges of Syracuse University.

The formal Interdisciplinary Program in Water Resources was organized in 1968 to supplement departmental programs by providing a sound basis for graduate academic programs designed to emphasize the multidisciplinary aspects of water resources. This effort recognized that water relationships are important in almost every aspect of human concern and merit attention as integrative and central elements rather than accessories. The Water Resources Program makes available to graduate students pertinent resources of the College and of Syracuse University, and where appropriate, those of other units of the State University.

The program is primarily for doctoral students. It is not structured in terms of required courses or content. Attention is given to the particular objectives of each student who enrolls in the program. Within the framework of the general graduate study requirements of the College, courses, programs and seminars are selected to attain the specific objectives and special interests sought by the student. The academic competence required is demanding. The programs arranged are broadly integrative rather than concentrated in a discipline. Critical review of the program proposed for each student is made by an assigned program committee to ensure that institutional standards are maintained and program objectives are met.

A major professor is assigned by the Program Leader to accept primary responsibility for the program of each student. Two additional faculty members in areas of expected academic or research emphasis are also selected. These three faculty members constitute the academic program committee for the student. The student is required to submit a formal report to the program committee consisting of a detailed work plan describing and defending his academic and research objectives and a schedule of courses and other elements of his contemplated study. This report is reviewed by the program committee, and is made a part of his permanent file. It is reviewed and updated at the beginning of each semester. The program committee will also serve as the thesis committee.

World Forestry

Graduate study and related research in world forestry is a College-wide activity supported by faculty representing the major areas of professional faculty specialization and broad backgrounds of foreign forestry experience. The nontechnical elements of the program are supported by a wide variety of course offerings in the Maxwell Graduate

School of Citizenship and Public Affairs, the Department of Geography and other departments of Syracuse University. Opportunities for field training and research in tropical forestry and related fields are available to qualified participants in this program, under cooperative agreements maintained by the College with the University of the Andes, at Merida, Venezuela, and the Institute of Tropical Forestry of the U. S. Forest Service, at Rio Piedras, Puerto Rico. The College also participates in the program of the Organization for Tropical Studies which provides opportunities for advanced study and research in tropical forestry and related fields for selected graduate students.

Graduate study in this field is aimed at supplementing and enriching the student's technical forestry knowledge and providing the broad background deemed necessary for effective service in foreign forestry. This includes service as forestry advisor, teacher and research specialist with national and international agencies, private business and industrial firms, philanthropic foundations and voluntary service organizations whose activities include the development and/or use of forest resources in other lands.

At the master's level, program emphasis is on the attainment of general competence in foreign languages, cultural anthropology, world geography, history, and international affairs, plus a broad understanding of the world forestry situation. While the candidate is urged to devote major effort to formal course work, a thesis is required to provide a creative experience in critical study and original thinking. Sufficient flexibility is maintained to enable the student to focus his studies on some aspect of world forestry either global, regional or national in scope.

At the doctoral level, program concentration is on a specialized discipline area such as forest botany, forest economics, forest management, silviculture, or wood products engineering. Orientation to the world forestry field in this case is achieved in part through the selection of formal course work, and in part through providing an opportunity for the student to conduct his thesis research in residence abroad. Major program emphasis is placed on a thesis representing a significant contribution in original study in a world forestry problem area.

Course Offerings

Graduate students at the College of Environmental Science and Forestry not only have the academic and research resources of their own institution, but also the resources of nearby Syracuse University and State University Upstate Medical Center.

In graduate programs at the College, Syracuse University courses are used extensively in the fields of mathematics, physics, chemistry, biology, engineering, economics, business and citizenship. The State University Upstate Medical Center has courses available for graduate programs in the areas of anatomy, biochemistry, cytology, microbiology, and physiology.

DESCRIPTION OF COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY COURSES

The courses offered by the College are grouped by general subject areas, and the number of credit hours appears after the course title. A credit hour means one recitation (or lecture) hour per week. Three laboratory hours are equivalent to one lecture hour.

Course Numbering System (Effective June, 1973)

Code Levels:

500—599 Graduate Courses designed expressly for graduate students, in areas supporting their specialization or interdisciplinary program, or for fifth year professional students with baccalaureate degrees (e.g. BLA students with B.S. in Environmental Studies), and available for undergraduate credit by selected upper division undergraduate students with superior academic records.

600—699 Graduate courses designed for beginning graduate students. Undergraduates are permitted admission only by petition with a well-documented justification approved by the undergraduate advisor and curriculum director and the instructor of the course.

700—899 Advanced graduate courses designed primarily for second and third year graduates and beyond, but available to all graduates.

900—999 Special graduate courses available only to doctoral students.

COURSE OFFERINGS

APPLIED MATHEMATICS (APM)

500. Introduction to Computer Programming for Graduate Students (3)
This basic course in computer use offered by the College is intended to provide the student with the skill and understanding needed to utilize digital computer languages for problem solving. The course includes a rather detailed study of Fortran IV, plus some discussion of an Assembly language and moderate study of Cobol and APL. To provide completeness, some attention is also afforded to techniques of representing information, managing files, error control and to operating systems and job control. This course or a demonstrated equivalent is a prerequisite to individual student use of the College computer facilities. Fall and Spring.

593. Introduction to Analysis of Variance (3)
Two hours of lecture, three hours of lab. One and two-way analysis of variance, multiple comparisons, subsamples, unequal sample size, tests of hypotheses, statistical estimation, determination of sample size. Fall.
Prerequisites: APM 491 or equivalent.
Note: This course will be dropped from the College offerings, effective Fall, 1976.

605. Theory of Probability Distributions (1-3)
Three hours weekly sessions over 5-14 weeks. Statistical problems and mathematical models; random experiments, random variables, probability, frequency and distribution functions of discrete, continuous and mixed random variables; functions of random variables and their probability distributions; mathematical expectation and its applications; discussion of the main theoretical distributions such as binomial, Poisson, negative binomial, normal, Gamman, Beta, exponential and others; applications of this framework to the model construction problem in the statistical, operations research and forest mensuration areas. Fall or Spring. Mr. Cunia.
Prerequisites: Two semesters of differential and integral calculus and an introductory course in Statistics, or permission of the instructor. The course can be taken in conjunction with APM 651—Operations Research I (for 1 credit hour) or independent of it for 1 to 3 credit hours.

610. Statistical Analysis (3)
Two hours lecture, three hours lab. A treatment of statistical inference, including paired design, group design, linear regression and correlation, one way analysis of variance and some applications of chi-square. Calculation of statistics, tests of hypotheses and proper interpretation of calculated statistics. Fall. Staff.

620. Analysis of Variance (4)
Three hours of lecture and recitation, three hours of lab. Multiway classifications in the analysis of variance, with emphasis on the development of models, including randomized blocks, latin squares, split plots, and factorial designs with fixed effects, random effects, and mixed effects; multiple and partial regression and correlation (including curvilinear), using matrix methods; analysis of covariance, higher order contingency tables, distribution free methods, and sequential testing. Spring.
Prerequisite: Graduate standing and an introductory course in statistics covering material through the one-way analysis of variance.

625. Introduction to Sampling Techniques (3)
Two hours lecture, three hours lab. Introduction to the scientific basis of sampling: selecting an appropriate sampling unit; choosing an efficient design; calculating sampling error; determining a sample size to meet stated objectives. Spring. Staff.
Prerequisite: APM 491 or equivalent.

630. Topics in Advanced Mensuration **(3)**
Two 1½ hours of lecture per week. Topics to meet students' interests are selected from the following areas: systematic, stratified and cluster sampling; ratio and regression estimates; photo interpretation and double sampling; sampling with unequal probabilities and 3P sampling; Continuous Forest Inventory (CFI) and Sampling with Partial Replacement (SPR). Introduction to Matrix Algebra and its application to Multiple Linear Regression, Weighted Least Squares Method, Volume Table Construction, and Analysis of Covariance by dummy variables. Applications of Mathematical Programming and simulation techniques to management problems involving optimization of cost functions. Fall. Mr. Cunia.
Prerequisites: ERM 436 and APM 491 or equivalent.

635. Multivariate Statistical Methods **(3)**
Estimation and inference for the multivariate normal distribution. Multivariate analysis of variances, factor analysis, principle components analysis, canonical correlation, discriminate analysis, cluster analysis. Spring. Mr. Stiteler.
Prerequisite: One semester of statistics.

651. Operations Research I **(3)**
Two 1½ hours of lecture. Stochastic or models applicable to managerial process or systems analysis. Elements of probability theory, theory of games and decision theory, queuing model, simulation techniques with applications to queuing and inventory problems, and, if time permits, Markov chains. Fall. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

652. Operations Research II **(3)**
Two 1½ hours of lecture. Deterministic or models applicable to managerial problems or systems analysis. Elements of Matrix Algebra, solving simultaneous linear equations, mathematical programming, classical optimization techniques, LaGrange multipliers. Linear programming transportation and allocation models, dynamic programming, network analysis and, if time permits, quadratic, parametric and integer programming. Fall. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

660. Information Processing Fundamentals **(3)**
The course presents problem solving and analytical structures, and practice in their application by use of a digital computer. Selected portions from the two general processing categories of numerical analysis and information systems are presented for discussion and study. The purpose is to develop an awareness with some understanding and proficiency in automated problem-solving systems. Spring.
Prerequisite: Integral calculus and proficiency in computer programming.

760. Computer Applications **(3)**
A course presenting some discussion and practice in the application of computers to the solution of complex large-scale problems. A study of simulation techniques provides the opportunity to apply a computer to the solution of problems normally considered outside the realm of classroom experience. A study of some programming systems permits the opportunity to see how computers are used to solve their own problems of efficiency concerned with time, space and reliability. Spring. Mr. C. N. Lee.
Prerequisites: APM 460 and APM 491 or the equivalents.

ENVIRONMENTAL AND RESOURCE ENGINEERING (ERE)

696. Advanced Topics **(2-3)**
Lectures, readings, problems, and discussions. Advanced topics as announced in the areas of environmental or resource engineering, building on one or more of the disciplines of the undergraduate curricula. Fall and/or Spring. Staff.

FOREST BIOLOGY (FBL)

540. Chemical Ecology **(3)**

Two hours of lecture and one hour of discussion. A treatment of biological phenomena incorporating elements of ecology, physiology and chemistry as a basis for development and behavior and survival. Emphasis is on intra- and inter-specific relationships involving chemical messengers at the organismal population and community levels. Spring. Mr. Simeone.

Prerequisites: Organic chemistry, general ecology, general physiology.

615. Advanced Limnology **(4)**

Note: SUNY Albany No. BIO 516.

Eight weeks, two full days a week. Comprehensive analysis of primary and secondary producers in a selected series of Adirondack lakes and streams. Lecture discussion sessions to serve to direct individual student projects detailing the flow of energy and circulation of matter in a variety of mountain habitats. Summer Session I & II, Cranberry Lake Biological Station. Mr. McNaught, SUNYA.

Prerequisite: BIO 202, 12 hours of biology.

621. Population Dynamics **(2)**

Note: SUNY Albany No. BIO 518.

Two full days per week for four weeks. Interrelationships of biotic and environmental factors that control population responses and interactions. Summer Session II, Cranberry Lake Biological Station.

670. Cytogenetics **(3)**

Two hours of lecture and one hour of seminar and discussion. Structure and behavior of chromosomes in animals and plants are considered. The effects of chromosomal aberrations and abnormal chromosome numbers on somatic and germ cell divisions, on the physiology and development of organisms with emphasis on human diseases and on populations including structure, speciation and evolution are discussed. Lecture demonstrations include tissue culture and cell hybridization methods for karyo-type analyses and somatic cell genetics. Spring (odd calendar years). Messrs. Lanier, Valentine and Neu.

Prerequisite: FBL 370 or permission of the instructors.

785. Histochemical Techniques **(3)**

One lecture and two labs. The techniques of the microtomecryostat, freeze-drying and freeze substitution, histochemical stains, and autoradiography in the elucidation of the constitution of cells and tissues. Spring (even calendar years). Mr. Tepper.

Prerequisites: Microtechnique and organic chemistry.

796. Topics in Biology

A course offered by the faculty for students interested in biology. Check the Schedule of Courses for details. Fall and Spring. Staff.

835. Membranes and Biological Transport **(3)**

Two hours of lecture and one hour of discussion. Composition, structure, and physical properties of membranes. Membrane functions including transport, bioelectricity and cell compartmentalization. Specific transport processes in biological systems. Fall (alternate years). Mr. Schaedle.

Prerequisites: One semester of biochemistry and an advanced physiology course, or permission of the instructor.

997. Biology Seminar **(1)**

One hour of lecture-discussion per week. The course emphasizes current concepts and developments in biology. Fall and/or Spring. Staff.

BOTANY (BOTANY AND FOREST PATHOLOGY) (FBO)

510. Mycology **(3)**
Two hours of lecture, three hours of laboratory. Fundamentals of the morphology, taxonomy, cytology, life histories and ecology of fungi. Laboratory experience in culturing and identification of fungi. Fall. Mr. Griffin.

515. Systematic Botany **(3)**
Two hours of lecture, three hours of laboratory. Identification, nomenclature and classification of flowering plants with special emphasis on local flora and on developing the ability to classify the plants of any region. Fall.
Prerequisite: FBO 310 or permission of the instructor.

530. Plant Physiology **(2)**
Two hours of lecture. Internal processes and conditions in higher plants with emphasis on physiological and biochemical concepts. For students majoring in the biological sciences. Spring. Mr. Wilcox.
Note: Botany majors electing this course for their concentration must also take FBO 531.

531. Plant Physiology Laboratory **(2)**
Two lab sessions. Introduction to current methods and procedures of physiological research including nutrition, tissue culture, photosynthesis, respiration and hormonal regulation of growth. Spring. Mr. Schaedle.
Prerequisites: FBL 330, corequisite FBO 530, or permission of the instructor.

561. Principles of Forest Pathology **(3)**
Three hours of lecture and discussion. Concepts and principles of tree diseases in relation to forest practice. Fall. Mr. Manion.
Prerequisite: FBO 360 or consent of instructor.

585. Plant Anatomy **(3)**
Two hours of lecture, three hours of laboratory. An introductory course in plant anatomy designed to familiarize the student with the organization and development of the primary and secondary plant body of higher plants. Spring. Mr. Tepper.
Prerequisite: FBO 100.

612. Phycology **(2)**
Note: SUNY Albany No. BIO 507.
Cranberry Lake Biological Station. Session II, every second or third summer. Two full days per week for four weeks. Study of the characteristic algae of selected Adirondack lakes and waters. SUNY Albany Staff.
Prerequisites: 15 hours of biology including general ecology and a course in the plant kingdom.

617. Adirondack Flora **(2)**
Note: SUNY Albany No. BIO 517.
Two full days a week for four weeks. Cranberry Lake Biological Station. Field study of the summer flora of the Adirondack Mountains. Session I. Mr. Baum.
Prerequisite: An elementary course in systematic botany.

625. Plant Ecology **(3)**
Two hours of lecture and discussion and one laboratory/discussion section per week. A first course in plant community ecology for beginning graduate students focusing on dynamics of community development and change and the processes of community analysis and description. Spring. Mr. Geis.
Prerequisite: A course in general ecology.

627. Bryoecology (2)
Two full days a week for four weeks. Field and laboratory work at the Biology Station. Study of the bryoflora of the major ecosystems of the Adirondack Mountain region. Summer Session I, Cranberry Lake Biology Station. Mr. Ketchledge.
Prerequisites: Survey of the plant kingdom; systematic botany; general ecology.
Special requirement: Students must be prepared to go on two overnight trips to isolated areas.

630. Fungus Physiology (3)
Two hours of lecture, one hour of discussion. Principles of growth, reproduction and differentiation of the fungi emphasizing the role of the environment in controlling fungal processes. Spring (even years beginning in 1970). Mr. Griffin.
Prerequisites: Two semesters of physiology or biochemistry.

636. Photosynthesis (3)
Two hours of lecture, one hour of discussion. Advanced study of photosynthesis on the cellular and organismal level. Specific topics will reflect basic concepts and current emphasis in this field. Fall of odd years.
Prerequisite: Two semesters of physiology or a course in biochemistry.

660. Phytopathology (3)
Two hours of lecture and discussion and three hours of Auto-Tutorial laboratory. Principles and concepts of plant pathology. Major diseases of ornamental plants, vegetable crops, fruit crops, field crops, and trees. This is an introductory plant pathology course for graduate students in all departments. Spring. Mr. Manion.

662. Wood Deterioration by Microorganisms (3)
Two hours of lecture, three hours of laboratory/field trip. Major types of fungus defects of wood and its products and principles of control. Special emphasis on chemistry of wood decay, wood durability, toxicants, lumber discolorations, heartrots and decay in forest products. Fall. Mr. Silverborg.
Prerequisite: Organic chemistry, FBO 360, or consent of instructor. Course offered in even calendar years.

715. Advanced Systematic Botany (2-3)
Lectures and laboratory. Field trips. Advanced study in the identification, nomenclature, and classification of flowering plants. Special emphasis on Gymnospermae, Compositae, and Gramineae. Fall.
Prerequisite: FBO 515 or equivalent.

725. Topics in Plant Ecology (2)
Two hours of seminar-discussion. An advanced course dealing with current research in plant community dynamics. May be repeated for additional credit. Fall.
Prerequisites: FBO 425 or 625 or consent of instructor.

733. Techniques in Plant Physiology (2-4)
Comprehensive study of techniques essential for research in plant physiology. Students may choose the instructors they wish to work with, and should consult the instructors for further details. Fall of every year. May be repeated for credit in different specialties. Staff.
Prerequisites: FBO 530 and 531 or an equivalent physiology course, biochemistry with laboratory, or consent of the instructor.

761. Topics in Phytopathology (3)
Two two-hour lecture-discussions. Discussions of specific phytopathological subjects. Topic selection is based on availability of expertise and will be announced in advance. Fall or Spring. Staff. This course may be repeated for credit in different specialties.

797. Botany Seminar **(1)**
Seminar discussions of subjects of interest and importance to the biology of plants. Fall and Spring. Staff.

798. Research in Forest Botany (Credit hours arranged according to nature of problem)
Advanced study in research problems in forest pathology, wood deterioration, tree physiology, anatomy, mycology, ecology, taxonomy and genetics. Typewritten report required. Fall and Spring. Staff.

810. Advanced Mycology, Homobasidiomycetes **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mrs. Wang.
Prerequisite: FBO 510. Course offered in odd calendar years.

811. Advanced Mycology, Heterobasidiomycetes **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mrs. Wang.
Prerequisite: FBO 510. Course offered in even calendar years.

812. Advanced Mycology, Ascomycetes **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mrs. Wang.
Prerequisite: FBO 510. Course offered in even calendar years.

813. Advanced Mycology, Myxomycetes, Phycomycetes, Fungi Imperfecti **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mrs. Wang.
Prerequisite: FBO 510. Course offered in odd calendar years.

825. Description and Analysis of Vegetation **(3)**
Two hours of lecture and discussion; one laboratory/field trip. An advanced course in measurement, sampling, and analysis of variables pertinent to vegetation structure and dynamics, and to vegetation-environment relationships. Fall.
Prerequisites: FBO 625, a course in statistics, or consent of instructor.

830. Physiology of Growth and Development **(2)**
Lecture. A study of the growth and development of plants and the physiological and biochemical processes that influence the development of form and structure in higher plants. Fall (even years). Mr. Wilcox.
Prerequisite: FBO 530, 585, and organic chemistry or permission of instructor.

870. Population Genetics **(3)**
Three hours of lecture. The principles and theorems of population genetics based upon gene frequencies and genic effects in theoretical populations. Effects of inbreeding, selection, mutation, fitness, migration, and other factors are considered. Composition and changes in natural and laboratory populations are related to genetic theory. Spring (even numbered years). Mr. Valentine.
Prerequisites: FBL 370, 371, one semester of calculus, APM 620, or permission of instructor.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

CHEMISTRY (FCH)

520. Nuclear and Radiation Chemistry **(2)**

The two one-hour lectures will cover the information required for the basic understanding of nuclear reactions, the types of radiation emitted, the instrumentation necessary to detect and measure this radiation, the principles of radioisotope tracer techniques and radiation chemistry which is the effect of radiation on organic systems. Visits to the Cornell Reactor and the Nuclear Medicine Department of the Upstate Medical Center will be arranged. Spring. Mr. Meyer.

Prerequisites: Physical, organic, and inorganic chemistry or by permission of the instructor.

Note: This course can be taken independently of FCH 521.

521. Nuclear Chemical Techniques **(1)**

The laboratory will consist of one four-hour laboratory class every two weeks, with one hour to be made up at the student's discretion to accommodate counting periods which extend over several weeks. A short movie by the AEC each week will be required for the sixth hour. The laboratory will give each student the opportunity to use the individual counting instruments, gain experience in the handling and preparation of radioactive samples and the use of the 1000 Curie cobalt source in radiation chemistry. Spring. Mr. Meyer.

Prerequisite: Physical, organic and inorganic chemistry or permission of the instructor. Advance tentative registration is required.

Corequisite: FCH 520.

530. Biochemistry I **(3)**

Three hours of lecture. General biochemistry with emphasis on cellular constituents and metabolic reactions. The chemical, physical and biological properties of amino acids, proteins, carbohydrates and their intermediary metabolism will be discussed. The chemistry of enzymes, energy transfers and biological oxidations will also be covered. Fall. Mr. Walton.

Prerequisite: One year of organic chemistry.

Pre- or corequisite: One year of physical chemistry.

531. Biochemistry Laboratory **(2)**

Six hours of laboratory. This course will stress techniques used in biochemical research. Techniques used include various types of chromatography, electrophoresis, and spectrophotometry and methods involved in the isolation, purification and assay of enzymes. Fall. Mr. Walton.

Prerequisite: One semester of quantitative analysis with laboratory.

532. Biochemistry II **(3)**

Three hours of lecture. Topics discussed are: application of tracer techniques to biochemistry, the chemical and biochemical properties of lipids, theories on the origin of life, photosynthesis and the biosynthesis of steroids and terpenes, plant aromatics, amino acids, porphyrins and other aspects of nitrogen metabolism. Spring.

Prerequisites: FCH 530 and its pre- and corequisites.

539. Principles of Biological Chemistry **(3)**

Three hours of biochemistry with emphasis on their relationship to biology. Topics include basic metabolic pathways, structure and function of proteins, enzymes, and nucleic acids, energy relationships and biochemical control mechanisms. Fall. Mr. Walton.

Prerequisite: A two-semester course in organic chemistry is desirable, but a one-semester course is acceptable. This course is not open to chemistry majors.

540. Chemical Ecology

This course is the same as FBL 540. Refer to description on page 44.

551. Polymer Techniques **(2)**

One hour of lecture and discussion and three hours of laboratory; lab reports. Techniques of polymer preparation: free radical solution and emulsion polymerization, copolymerization. Molecular weight determination by light scattering, osmometry, viscosity, ultracentrifugation. Structure characterization by X-ray diffraction, electron microscopy, nuclear magnetic resonance, optical rotatory dispersion, polarized microscopy, stress-strain and swelling equilibrium. Fall. Mr. Sarko.

Prerequisites: One year of organic and one year of physical chemistry.

552. Polymer Processing and Technology **(3)**

Industrial methods of production and processing of polymeric materials such as fibers, films, plastics, elastomers, foams, composites, adhesives and coatings, including discussions on the correlation between polymer structure and polymer properties. Spring. Mr. Smid and Staff.

650. Physical Chemistry of Polymers I **(3)**

Three hours of lecture. Includes: thermodynamics of polymer solutions, phase equilibria, fractionation, structure-property relationships, elementary chain statistics, molecular geometry, network elasticity, polyelectrolyte theory and viscosity. Fall. Mr. Smith.

Prerequisites: One year organic chemistry and one year physical chemistry.

651. Physical Chemistry of Polymers II **(3)**

Three hours of lecture. Viscoelasticity. The glassy state and glass transition temperature. The crystalline state and crystallization kinetics. Characterization of structure and morphology of polymer solid states. Survey of structure and properties of native polymers. Spring. Mr. Sarko.

Prerequisites: One year of organic and one year of physical chemistry.

652. Organic Chemistry of Polymers I **(3)**

Three hours of lecture. A broad survey of the chemistry of polyfunctional molecules and methods for their conversion to high molecular weight materials. Synthesis of a variety of specialty polymers and chemical reactions on natural and synthetic polymers. Some relations between molecular structure and useful properties. Fall. Mr. Caluwe.

Prerequisites: One year of organic chemistry.

653. Organic Chemistry of Polymers II **(3)**

Three hours of lecture. Kinetics and mechanism of polymerization processes, with emphasis on addition homo- and copolymerization relations initiated by radical, cationic and anionic initiators. Mechanism of stereospecific polymerization. Structure of polymers. Reactions on polymers and their modification for specific end uses. Block and graft polymers. Spring. Mr. Smid.

Prerequisites: One year of organic chemistry and one year of physical chemistry.

796. Special Topics in Chemistry **(1-3)**
(Credit hours arranged according to nature of topic)

Lectures, conferences and discussion. Advanced topics in physical chemistry, organic chemistry, or biochemistry. Fall and Spring. Staff.

798. Research in Chemistry
(Credit hours arranged according to nature of problem)

Independent research in physical and organic chemistry of synthetic polymers, physical and organic chemistry of natural polymers, organic chemistry of natural products, ecological chemistry and biochemistry. One typewritten report required. Fall and Spring. Staff.

830. Topics in Plant Biochemistry **(3)**
Three hours lecture and discussion. Covers topics in biochemistry unique to plants, including photosynthesis, biosynthesis of cellwall components, phenolics, terpenes, nitrogen metabolism, structure and function of plant hormones, biochemistry of differentiation and growth regulatory mechanisms. Spring (alternate years). Mr. Walton.
Prerequisites: FCH 530, FCH 532, or equivalents.

850. Organic Chemistry of Polymers **(3)**
Three hours of lecture, discussion and recitation. A broad survey of polymer forming reactions and polymeric structures. Special problems in stereochemistry, polymerization mechanisms and the synthesis of a variety of specialty polymers. Some relations between molecular structure and useful properties. Spring. Mr. Caluwe.
Prerequisites: One year of organic chemistry and FCH 450.

855. Physical Chemistry of Polymers **(3)**
Three hours of lecture and discussion. Introduction to statistical mechanics of polymers: general problem of random flight, chain statistics and conformations, partition functions: network statistics and rubber elasticity, birefringence, swelling, crystallization. Scattering phenomena: theory of light scattering, scattering from a sphere, scattering from liquids and solids, anisotropic scattering, X-ray scattering. Fall or Spring. Mr. Sarko and Mr. Smith.

884. Organic Natural Products Chemistry **(3)**
Three hours lecture. The chemistry of terpenoids, steroids and alkaloids with an emphasis on the determination of structure by both modern instrumental methods and chemical degradation. Biogenetic considerations and the confirmation of structure by synthesis are covered. Fall or Spring. Mr. LaLonde.
Prerequisite: One semester of advanced organic chemistry.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

997. Seminar **(1)**
Seminars scheduled weekly; an average of twenty to thirty seminars are given annually. Discussion of recent advances in chemistry. Credit is given only once to a student. Fall and Spring. Mr. Smith.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

ENGINEERING (FOREST ENGINEERING) (FEG)

563. Photogrammetry I **(3)**
Two hours of lecture and discussion, three hours of laboratory and discussion. Basic photogrammetric and photo interpretation concepts as a means of acquiring reliable data for engineering and management planning. Potentials, limitations, instrumentation, and unique requirements are considered. Fall and Spring. Mr. Brock.
Prerequisite: FEG 271 (or FEG 371 concurrent) or equivalent.

640. Water Resource Systems **(3)**
Three hours of lecture and discussion per week. Fundamentals of the systems approach to complex water resource problems. Characteristics of water resource systems, related to systems engineering methodologies. Quantitative and qualitative subsystems are considered in a technical nature which exposes the socio-legal-political interfaces of water resource decision making. Fall and/or Spring.
Prerequisite: FEB 340 or equivalent.

652. Remote Sensing Interpretation **(3)**
Two hours of lecture and three hours of laboratory per week. Introduction with a qualitative emphasis to the fundamentals of acquiring, analyzing and utilizing remote sensing data in the performance of natural resource inventories, environmental quality surveys, site development studies and land use analyses. Oriented for multidisciplinary participation. Fall and/or Spring. (Not open to students having previous credit for FEG 352). Mr. Lillesand.
Prerequisite: Physics and Calculus or consent of instructor.

655. Remote Sensing Measurements **(3)**
One hour of lecture, one hour of discussion and three hours of laboratory comprising an in-depth coverage of the theory, design and application of remote sensing systems and techniques employed to obtain precise spectroradiometric measurements in vegetation surveys, site engineering, data acquisition endeavors and environmental monitoring efforts. Photographic and non-photographic systems are considered. A variety of field and laboratory measurement endeavors employing precision remote sensing equipment is included. Fall. Mr. Lillesand.
Prerequisite: FEG 352 or 652 and FEG 363 or 563 or consent of instructor.

660. Theory of Errors and Adjustments **(3)**
The theory of errors and adjustment of observations oriented toward geodesy and photogrammetry. Topics include error definitions, weighted observations, method of least squares, matrix algebra in adjustments, variance-covariance matrix, the error ellipse and the general case of adjustment. Fall or Spring. Mr. Brock.
Prerequisite: Calculus; a beginning course in Statistics.

664. Photogrammetry II **(3)**
Mathematical theory of photogrammetry including space resection, orientation and intersection. The theory and use of photogrammetric analogue computers in providing resource engineering maps. Fall. Mr. Brock.
Prerequisite: FEG 563 or equivalent.

665. Terrestrial and Nontopographic Photogrammetry (3)
Two hours of lecture, three hours of laboratory per week. The theory and applications of terrestrial and nontopographic photo measurements. Photo-Theodolites, short-focus cameras and microscopes are used and calibrated to provide meaningful quantitative data from photographs. Spring. Mr. Brock.
Prerequisites: FEG 363 and APM 360 or equivalent.

674. Geometric Geodesy **(3)**
An introductory graduate level course for those without previous background in theoretical geodesy. Topics covered include position determination for short and long lines on the ellipsoid, the ellipsoidal triangle, the parametric equations, three-dimensional geodesy, and mappings of the ellipsoid. Fall. Mr. Bender.
Prerequisite: Permission of the instructor.

675. Astronomic and Gravimetric Geodesy **(3)**
An introductory graduate level course in Geodetic Astronomy and the gravity field of the Earth. Topics covered include updating star positions; precise time keeping; position determination by natural and artificial satellites; the fundamental concepts of Gravimetric Geodesy, including the potential function; attraction; undulations of the geoid and deflections of the vertical. Fall. Mr. Bender.
Prerequisite: FEG 674.

760. Analytical Photogrammetry I **(3)**
Two hours of lecture, three hours of laboratory per week. Mathematical theory of photogrammetry including space resection, orientation, intersection and aerial triangulation. Fall. Mr. Brock.
Prerequisites: FEG 363 and APM 360 or equivalent.

761. Analytical Photogrammetry II **(3)**
Two hours lecture, three hours laboratory. A continuation of FEG 760 leading to more extensive analytical solutions with frame and nonconventional photography. The distortions present in photographs are analyzed and camera and comparator calibrations are treated. Spring. Mr. Brock.
Prerequisite: FEG 760.

762. Instrumental Photogrammetry I **(3)**
Two hours of lecture, three hours of laboratory. The theory and practice of extracting information from photographs with the aid of photogrammetric plotters. Fall. Mr. Brock.
Prerequisite: FEG 363 or equivalent.

763. Instrumental Photogrammetry II **(3)**
Two hours lecture, three hours laboratory. The major subjects of study are photogrammetric optics, the theory and design of optical and mechanical plotters and automatic mapping systems. Spring. Mr. Brock.
Prerequisite: FEG 762 or permission of instructor.

797. Seminar **(1)**
Literature surveys and seminars on topics of Forest Engineering interest and importance. Subjects to be generated by faculty and students and to be announced prior to registration. Fall and Spring. Staff.

798. Research in Forest Engineering
(Credit hours arranged according to nature of problem)
Independent research topics in Forest Engineering for graduate students who desire specialized knowledge or research experience. Tutorial conferences, discussions and critiques scheduled as necessary. One typewritten report (original and one carbon) required. fall and Spring. Staff.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral dissertation. Fall and Spring. Staff.

ENTOMOLOGY (FOREST ENTOMOLOGY) (FEN)

560. Environmental Toxicology of Insecticides **(2)**
Two hours of lecture. Basis of action of insecticides in living systems, behavior of insecticides and microtoxicants in environment, interaction of insecticides and biological systems. Fall.
Prerequisite: FBL 330 or equivalent course in physiology or biochemistry.

580. Insect Morphology **(3)**
Two hours of lecture, three hours of laboratory. A comparative study of the external morphology of insects emphasizing evolutionary trends, especially modifications of homologous structures. Topics of special importance include intersegmental relationships, feeding, sensory mechanisms, locomotion and reproduction. Spring. Mr. Kurczewski.
Prerequisite: FEN 350.

610. General Insect Taxonomy **(3)**
Two hours of lecture, three hours of laboratory. Identification and classification of the important orders and families of insects; acquaintance with pertinent taxonomic literature and use of keys; and understanding of evolutionary principles and concepts and a knowledge of systematic theory and practice. Insect collection required. Fall. Mr. Kurczewski.
Prerequisites: FEN 350, FEN 580.

620. Aquatic Entomology **(3)**
Two hours of lecture, three hours of laboratory. The biology, ecology and identification of fresh water insects, with emphasis on the role of aquatic insects in the hydrobiome. Fall. Mr. Brezner.
Prerequisite: FEN 350 or its equivalent.

630. Insect Physiology **(3)**
Two hours of lecture, three hours of laboratory. Study of the life processes in insects; introduction to modern physiological instrumentation and laboratory methods. Spring. Mr. Brezner.
Prerequisite: FBL 330.

660. Insecticide Toxicology Laboratory **(2)**
One hour of discussion and three hours of laboratory. Laboratory experiments in mode of action and behavior of insecticides, biological and instrumental analysis of insecticides including tracer analyses. Spring, odd years.
Prerequisite: FEN 560 or equivalent and consent of instructor.

720. Population Dynamics of Forest Insects **(3)**
Two hours of lecture, one hour seminar. Interacting environmental factors which influence the relative abundance and distribution of forest insects, ecological principles as applied to problems in forest entomology, and pest management. Introduction to theories of population regulation and the study of the dynamics of forest insect populations; individual problem and seminar. Fall. Mr. Allen.
Prerequisites: FEN 350, FZO 520, APM 491, or equivalents.

796. Special Topics in Forest Entomology
(Credit hours arranged according to nature of work)
Special instruction, conference, advanced study, and research projects in the fields of insect toxicology, insect physiology, taxonomy of immature insects, phases of biology and ecology of insects. Typewritten report required in some fields. Fall and Spring. Staff.

797. Seminar **(1)**
One hour of conference per week. Assigned reports and discussion of topics in entomology. Fall and Spring. Mr. Nakatsugawa and Staff.

798. Research Problems in Forest Entomology
(Credit hours arranged according to nature of problem)
Comprehensive report required in some projects. Fall and Spring. Staff.

810. Advanced Insect Taxonomy **(3)**
Two hours of lecture, three hours of laboratory. Methods, procedures, and concepts of systematics. Examples and material will be drawn from among important groups of forest insects. Fall. Mr. Lanier.
Prerequisites: FEN 580 and FEN 610.

860. Advanced Toxicology of Insecticides **(3)**
Three hours of lecture and discussion. Review of current topics in toxicology of insecticides and related foreign compounds. Fall. Mr. Nakatsugawa.
Prerequisite: FEN 560, FCH 530 **and** consent of instructor.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and spring. Staff.

FOREST ZOOLOGY (FZO)

520. Terrestrial Community Ecology **(3)**
Two hours of lecture, three hours of laboratory. Relations of terrestrial animals to their physical, chemical and biological environment. Emphasis on community principles, succession and terrestrial adaptations. Fall. Mr. Dindal.
Prerequisite: A course in basic ecology.

525a. Physical and Chemical Limnology **(1)**
Modular format, two hours of lecture/week for first seven weeks of fall semester. An introduction to the physics and chemistry of inland waters with particular emphasis on lakes.
Prerequisites: Junior standing, an introductory physics course and an introductory chemistry course. Fall. Mr. Werner.

525b. Introduction to Biological Limnology **(1)**
Modular format. Two hours of lecture/week for last seven weeks of fall semester. An introduction to the biology of inland waters. Particular emphasis is placed on the aquatic environment as a habitat and the effect of changes in this environment on the structure and function of the biological communities contained therein.
Prerequisites: FZO 525a. Fall. Mr. Werner.

525c. Limnology Laboratory **(1)**
One laboratory or field trip/week. An introduction to Limnology techniques and the taxonomy of aquatic organisms. Field trips to local aquatic habitats. FZO 525a. and FZO 525b must be taken concurrently or previously. Fall. Mr. Werner.

620. Invertebrate Symbiosis **(3)**
Two hours of lecture and one three-hour laboratory. An introduction to the ecology and evolution of interspecific relationships of invertebrates. Spring, even years. Mr. Dindal.
Prerequisites: FBL 320, FZO 411.

626. Ecology of Adirondack Fishes **(2)**
Cranberry Lake Biological Station, Session II, every third summer. Half time for four weeks. Study of the ecology of fishes, with detailed individual investigation of the ecology of Adirondack fishes. Mr. Werner.
Prerequisite: FZO 416.

627. Field Ornithology **(2)**
Note: SUNY Albany, No. BIO 601
Two full days per week for four weeks. Field study of the ecology, distribution and behavior of birds of the Adirondack region. Techniques used in conducting field studies in avian biology will be emphasized. Summer Session A, Cranberry Lake Biological Station. Staff, SUNY at Albany.

628. Vertebrate Population Ecology **(3)**
Two hours of lecture and one three-hour laboratory per week. Fundamental parameters of population structure and change with emphasis on vertebrate species. Spring. Mr. Ringler.
Prerequisite: A course in general ecology.

635. Behavioral and Physiological Ecology **(3)**
Two hours lecture, one hour discussion. An examination of the concepts of animal adaptations to ecological change from a behavioral point of view. Particular emphasis will be placed on the role the environment plays in shaping the behavior of a given species. Behavioral and physiological responses to environmental conditions will be treated as a continuum. Spring Semester, odd-numbered years. Mr. Muller-Schwarze.

650. Biology and Management of Waterfowl **(2)**
A consideration of the identification, life history, ecology and economic importance of waterfowl of the Atlantic Flyway. The management of local, flyway and continental waterfowl populations, including the establishment of hunting seasons, will be discussed. One Saturday field trip. Fall, odd years. Mr. VanDruff.

670. Vertebrate Behavior **(3)**
Two hours lecture, three hours laboratory. In-depth study of the major concepts of animal behavior associated with behavioral genetics, development orientation and social behavior. Spring. Mr. Price.
Prerequisite: FZO 570.

700. Forest Zoology Trip **(2)**
A 7 to 10 day trip to (1) agencies engaged in zoological research, management, and administration, or (2) regions or areas of unusual biological interest. A final report is required. Estimated student expense, $75.00. Fall or Spring. Staff.

720. Topics in Soil Invertebrate Ecology **(3)**
Two one-hour lecture-discussion periods and a three-hour laboratory. Study of literature relating to soil invertebrate microcommunities; taxonomy, culturing, and collection methods of soil fauna; student will conduct an individual research problem. Spring. Odd years. Mr. Dindal.
Prerequisite: Permission of instructor.

725. Zoogeography **(3)**
Two hours of lecture, three hours of laboratory. Geographic distribution of vertebrate animals, factors determining their distribution and nature of range occupied. Fall. Alternate odd years.

727. Seminar in Aquatic Ecology **(1)**
Two hours lecture and discussion. A seminar to explore in some depth areas of current research in aquatic ecology. Fall. Even years. Messrs. Werner and Ringler.
Prerequisite: Six credits in Aquatic Ecology.

750. Advanced Wildlife Management **(3)**
Two hours lecture, three hours laboratory. Advanced wildlife management with emphasis on regional and administrative wildlife problems. Extended trips (two weekend trips) are required. Spring. Mr. Chambers.
Prerequisite: FZO 455 or permission of the instructor.

797. Forest Zoology Seminar **(1)**
Two hours of discussion and assigned reports on current problems and new developments in forest zoology. Fall and/or Spring. Staff.

798. Problems in Forest Zoology
(Credit hours to be arranged)
Hours to be arranged. Individual study of special problems in forest zoology. One typewritten report (original and one carbon) required. Fall and/or Spring. Staff.

835. Invertebrate Physiology **(3)**
Two hours lecture, three hours laboratory. A study of the physiologic mechanisms employed by invertebrates other than insects in coping with the exigencies of their environment. Fall or Spring. Alternate years. Mr. Hartenstein.
Prerequisites: FZO 411 and FZO 330.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

950. Topics in Wildlife Biology **(1-3)**
Hours to be arranged. Group study of a wildlife management topic. Fall or Spring. Mr. Chambers.
Prerequisite: Six credits of wildlife management courses.

970. Topics in Animal Behavior **(2)**
Two hours lecture and discussion. A seminar-type course designed to explore in depth selected and controversial subject areas in animal behavior. Fall or Spring. Mr. Price.
Prerequisite: FZO 670 or equivalent.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

LANDSCAPE ARCHITECTURE (LSA)

522. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Studio problems, research, drafting and field trips. Concentration on complex urban problems. Concern for social and psychological considerations of the individual and large groups of people, their interaction and resultant forms of the environment. Spring.
Prerequisite: Permission of instructor.

524. Experimental Landscape Design Studio V **(16)**
48 hours per week. The articulation of the study proposal established in LSA 425, as approved by faculty, through research, readings, field study with graphic and written documentation, and group discussion. Academic study in an off-campus location in an area of landscape architectural significance, as described and delineated in a student-prepared proposal approved by the faculty. Not available for graduate credit. Fall or Spring.
Prerequisites: LSA 425 or equivalent and LSA 423 or permission of instructor.

525. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Investigation of a problem in landscape architecture as proposed by the student and conducted in conjunction with faculty advisor. Spring.
Prerequisite: Permission of instructor.

527. Landscape Design Studio VI **(4)**
Twelve hours studio per week. Studio problems, research, reports and field trips. Concentration on regional landscape problems, the techniques of their analysis and derivation of their significance to the practice of landscape design. Spring.
Prerequisite: Permission of instructor.

529. The Major Elements of Environmental Design **(3)**
Lectures, readings, discussions and studios. The course presents an introductory survey of environmental design methods and associated skills and techniques. While studio work is engaged, no design background is required. Fall.

530. Herbaceous Plant Materials **(2)**
Two hours of lectures, study problems, assigned readings and field trips per week. Identification, understanding and design use of nonwoody plants. Fall.
Prerequisite: Permission of instructor.

532. Woody Plant Materials **(3)**
Three hours of lecture per week. Field study, lectures, slide presentations and readings. An elective course providing opportunity for extension of basic knowledge in the identification and design of woody plant materials in professional practice. Fall or Spring.
Prerequisites: LSA 533 and LSA 432 or permission of instructor.

533. Plant Materials **(3)**
Field trips and discussion. Ornamental woody plant identification. Observation and sketches of outstanding examples of planting design. Three weeks, Summer Session.
Prerequisite: Permission of instructor.

542. Highway Location and Design **(3)**
Two hours of lecture, three hours of studio per week. Lectures, assigned reading, studio projects, field trips. Environmental, engineering and human factors which determine highway location and design, particularly as they relate to landscape architectural concerns. Location, alignment, geometric design, drainage, roadbed construction, pavements, roadside development. Fall or Spring.
Prerequisites: LSA 343 and 440 or permission of instructor.

545. Professional Practice Studio II **(2)**
Three hours of studio, one hour of recitation per week. Studio problems research, discussion and recitation sessions on the processes and methods of office practice. Emphasis on all aspects of site-development. Spring.
Prerequisite: Permission of instructor.

547. Principles of Professional Practice **(2)**
Two hours of lecture per week. Lectures, assigned readings, reports, cost estimates, specifications, contracts, professional ethics, registration laws, professional practice. Spring.
Prerequisite: Upperclass standing.

562. Architecture **(3)**
Two hours of lecture, three hours studio. Discussion and investigation of the principles of architectural design and procedures of architectural practice. Functional building systems coupled with site and program considerations as to their relative impacts on architectural form. Spring.
Prerequisite: Permission of instructor.

595. Selected Readings in Landscape Architecture **(1-3)**
Exploration of selected readings in depth with individual independent study upon a plan submitted by the student and related to credit hours assigned. Upon approval of the instructor, the student may systematically investigate some subject area encountered in regularly scheduled courses or may initiate research on a variety of subject areas of determined relevance. Fall, Spring and Summer Session.
Prerequisite: 5th year status or permission of instructor.

597. Landscape Architecture Seminar **(3)**
Three hours of seminar per week. Discussion of current social, political, cultural and technological problems as to their relationship to the physical environment. Fall and Spring.
Prerequisite: Permission of instructor.

598. Research Problem **(1-3)**
Independent study of selected areas of environmental interest. Emphasis on a self-disciplined study, development of procedures and techniques to be employed in environmental design and planning. Engagement with specific sites and problems as proposed for study by individual communities. Fall and Spring. Enrollment at periodic intervals throughout the semester.
Prerequisite: Permission of instructor.

620. Graduate Studio I **(4)**
Twelve hours of studio per week. Disciplines and techniques used by the landscape architect in problem identification, analysis and solution strategies. Emphasis is on processes, not on product. Fall.
Prerequisite: Permission of instructor.

650. Determinants of Urban and Regional Land Use **(3)**
Three hours of discussion per week. This course will provide an introduction to social science theories of land use patterns. The nature of social, economic and political processes are explored in order to determine how the relationship of such factors effects the development of the physical environment. Understanding of these processes provide a basis for urban and regional planning. Fall.
Prerequisite: Permission of the instructor.

651. Process of City and Regional Planning **(3)**
Three hours of seminar per week. The purpose of this course is the introduction of planning as a process of decision making and to familiarize graduate students with its scope and content. The course relies upon lectures and readings to develop introductory knowledge as well as seminars and discussions to cover the constitutional basis, tools, and techniques and the current directions of planning. Spring.
Prerequisite: Permission of instructor.

653. Environmental Land Use Planning **(3)**
An introduction to the interdisciplinary techniques and emphasis of environmental land use planning. Consideration of the underlying ecological and planning philosophies. Readings and discussions are used in order to familiarize students with the disciplines involved and the process of data analysis, synthesis and plan formulation. Case studies and research projects used to enhance understanding.
Prerequisite: Permission of instructor. Fall and Spring.

654. Open Space Planning **(3)**
Three hours of seminar per week. An introduction of concepts of open space planning related to urban, suburban, new town and regional land use. An investigation of contemporary methods for open space preservation through private and municipal efforts will include inventory and analysis techniques for identifying community needs and physical resources. Fall.
Prerequisite: Permission of instructor.

655. Public Policy and Environmental Form **(3)**
Three hours of seminar per week. This course investigates public policy decisions as they effect the physical and social patterns of the environment. Seminar discussions based on readings and case study investigation. Spring.
Prerequisite: Permission of the instructor.

697. Seminar—Topics and Issues of Physical Environment **(2)**
Current topics for discussion are selected in order to acquaint the entering graduate student with a generalized view of the issues of the physical environment. Fall.
Prerequisite: Permission of the instructor.

699. Research Methods and Techniques **(2)**
Research methods, techniques and information sources pertinent to landscape architecture are surveyed and evaluated. Spring.
Prerequisite: Permission of instructor.

711. Human Behavior and Environmental Form **(3)**
Consideration of the nature and dynamics of people's movements in space as clues to their relationship with their environments. An examination of the basic social and behavioral concepts that relate to the human use of the urban environment. Concepts such as behavior patterns, territoriality, cognitive mapping, urban images, preference, neighborhood and community will be explored within the framework of "social space." The implications of such behavioral studies in the design of the environment will be considered.
Prerequisite: Permission of the instructor. Fall and Spring.

720. Graduate Studio II **(4)**
Twelve hours of studio per week. A multidisciplinary approach to the solution of one or more environmental problems of concern to the landscape architect. Because of the multivariable complexity of environmental problems, students pursuing various degree programs are invited to utilize this studio. Spring.
Prerequisite: LSA 620 or permission of instructor.

721. Graduate Studio III **(4)**
Twelve hours of studio-workshop per week. This is an extension of LSA 720, Graduate Studio II, with the engagement of additional problems. Fall.
Prerequisite: LSA 720 or permission of instructor.

730. Plant Materials IV **(2)**
Lecture, field work, trips. Special study of woody and herbaceous plant materials, greenhouse operation and other horticultural practices. Spring.

731. Plant Materials **(3)**
Seminars, individual conferences, field trips, readings. Guided individual study in aspects of plant materials related to landscape architecture. Fall or Spring.
Prerequisite: LSA 730 or permission of instructor.

740. Landscape Architectural Construction **(3)**
Lectures, drafting. Detailed study of special landscape construction problems. Preparation of estimates, contracts and specifications. Fall.
Prerequisite: LSA 542.

750. City and Regional Planning **(3)**
An introduction to methods of city and regional planning through the study of contemporary planning problems. Readings, discussions and reports. Fall and Spring.
Prerequisite: Permission of instructor.

752. Urban and Regional Systems Dynamics **(3)**
Lectures and workshop. The major concerns of this course are application of systems dynamics; basic principles of systems dynamics; and system dynamics modeling. This technique is investigated as a useful tool in modeling many landscape architectural and planning problems. No prior computer experience is necessary. Fall.
Prerequisite: Permission of instructor.

757. Methods of Corridor Location **(3)**
Three hours of lectures per week. This course emphasizes study of corridor types, traditional economic determinism, and the emergence of environmental, aesthetic, and social concerns. Landscape architectural methods for corridor location and evaluation are reviewed and compared. These methods include graphic overlays, automated data bank, unified scoring systems, and multiple accounts. Students will engage a course project. Spring.
Prerequisite: Permission of instructor.

797. Seminar **(2)**
Two hours per week. Discussion of current topics, trends and research related to landscape architecture, planning, and management. Fall and Spring.
Prerequisite: Permission of instructor.

798. Research Problem
(Credit hours to be arranged according to nature of problem)
Special study of assigned problems relating to landscape architecture or planning, with emphasis on critical thinking. Fall and Spring.
Prerequisite: Permission of instructor.

799. Research Topics **(2)**

Research trends and current research needs pertinent to landscape architecture are reviewed and evaluated. The student develops a topic area and a proposed strategy for terminal study. Fall.

Prerequisite: LSA 699.

899. Master's Thesis **(Credit hours to be arranged)**

Research and independent study for the master's degree and thesis. Fall and Spring.

PAPER SCIENCE AND ENGINEERING (PSE)

575. Unit Operations I: Fluid Mechanics and Heat Transfer **(3)**

Three hours of lecture and four hours of recitation per week for the first 9 weeks of the semester. The study of momentum and heat transfer. Pipeline and duct design, pump and blower selection, flow measurement, open channel flow, heat transfer by conduction, convection, radiation, including equipment design and selection. Fall. Mr. Stenuf.

Prerequisites: FCH 221 and 223, CHE 106, 116, 346, 356, PHY 103, 104, PSe 300, 301, 370 or equivalents.

576. Unit Operations II: Process Control and Mass Transfer **(2)**

Two hours of lecture and four hours of recitation per week for the last 6 weeks of the semester. The study and application of measuring means, remote signal transmission, and control elements. Response to signals, lag, dynamic error, cycling and other phenomena of process control are discussed in relation to the standard modes of control, including two-position, single-speed floating, proportional, proportional-speed floating, proportional-reset, proportional-reset-rate, cascade control, relation of the process variables to open and closed loop computer applications.

The fundamentals of mass transfer humidification and air conditioning as applied to industry and as found in the environment—climate and weather conditions. Fall. Mr. Stenuf.

Prerequisite: PSE 575.

578. Unit Operations III: Mass Transfer **(3)**

Three hours of lecture and four hours of recitation per week for the first 9 weeks of the semester. The study of mass transfer and application to the design and operation of equipment for drying, gas absorption, distillation and extraction. Each operation is treated as a practical unit complete with application of heat transfer, fluid flow, thermodynamics and instrumentation. Spring. Mr. Stenuf.

Prerequisite: PSE 576.

579. Unit Operations IV: Recovery Processes Operations **(2)**

Three hours of lecture and four hours of recitation per week for the last 6 weeks of the semester. The study of industrial recovery processes operations including evaporation, filtration, sedimentation, centrifugation, small particle technology and fluidization, and reverse osmosis. Each operation is treated as a practical unit complete with application of heat transfer, fluid flow, thermodynamics and instrumentation. Spring. Mr. Stenuf.

Prerequisite: PSE 576.

661. Pulping Technology **(4)**

Two hours of lecture and six hours of laboratory. Discussion of pulping and bleaching processes. Effects of chemicals and physical variables on the wood components and pulp properties; chemistry involved. Experiments in pulping and bleaching, and pulp evaluation. Fall. Mr. Gorbatsevich.

Prerequisites: PSE 370, CHE 346 and CHE 256.

Note: A student may not enroll in or receive credit for both PSE 461 and PSE 661.

665. Paper properties **(5)**
Three hours of lecture, six hours of laboratory and discussion. Evaluation and study of the physical, optical, and chemical properties of paper and the interrelationships existing between paper manufacturing methods, papermaking additives, test results and the ultimate properties desired in the finished paper. Fall.
Note: A student may not enroll in or receive credit for both PSE 465 and PSE 665.

666. Paper Coating **(3)**
Two hours of lecture, three hours of laboratory. Evaluation and study of the various coating processes and materials used by the paper industry to impart special properties to paper. Relationships of various components, flow properties of coating mixtures and evaluation of their effect on coated paper properties will be studied. Spring.
Note: A student may not enroll in or receive credit for both PSE 466 and PSE 666.

775. Industrial Thermodynamics **(3)**
The study and application of thermodynamics, including the first and second law, phase relationships, thermochemistry, the production of work and equilibrium relationships. Fall. Mr. Stenuf. Course given in even calendar years.
Prerequisites: CHE 346, CHE 356, or equivalent.

778. Metallurgy and Corrosion for the Paper Industry **(3)**
Three hours of lecture. The study and application of metallurgy and corrosion for the Pulp and Paper Industries. Fall. Mr. Stenuf. Course given in odd calendar years.
Prerequisites: CHE 346, CHE 356, or equivalent.

796. Special Topics **(1-3)**
Lectures, conferences and discussions. Advanced topics in chemical engineering, chemistry and physics as related to fibers, pulps, and paper. Fall and Spring. Staff.

797. Seminar **(1)**
Discussions of assigned topics in fields related to pulp and paper technology. Fall and Spring. Staff.

798. Research in Pulp and Paper Technology
(Credit hours arranged according to nature of problem)
Hours to be arranged. Problems in pulp and paper technology are assigned to properly qualified graduate students. One typewritten report (original and one carbon) required. Fall and Spring. Staff.
Prerequisites depend upon nature of problem.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

RESOURCE MANAGEMENT AND POLICY (RMP)

588. The Law of Natural Resource Administration **(3)**
Three hours of lecture and discussion. An introduction to the law concerning the procedures, powers and judicial review of public agencies responsible for the management of natural resources. Topics will include the extent of an agency's rule-making power and the rights of aggrieved parties to appeal from agency decisions. Spring. Mr. Horn.
Prerequisite: ERM 460 or equivalent course in public administration.

601. Introduction to Multiple Use Management **(3)**
Three hours of lecture and discussion. Goals, processes and problems of timber, recreation, wildlife and watershed management are considered individually and in a multiple-use context. Fall. Staff.

606. Management Principles and Processes **(3)**
Three hours of lecture and group discussion. The central focus of this course is on decision-making, organization and information theories as they relate to the total management process. Spring.
Prerequisite: Basic understanding of management functions and processes as found in FMG 454. Available to qualified seniors.

611. Economics of the Forest Business **(3)**
Two hours of lecture, three hours of laboratory. Economic evaluation of alternative uses of land, labor and capital in the operation of forest properties and related marketing and processing enterprises. Emphasis is on application of principles and methods of economic analysis. Part of the term is spent in appraising a forest property and preparing a plan for its operation. Complementary to instruction in ERM 456. Spring. Mr. Christiansen.
Prerequisite: ERM 463 or permission of the instructor.

629. Environmental Impact: Principles and Strategies **(3)**
Three hours of lecture and discussion. Principles and theory of environmental impact and statements of impact as required by Federal Law. Administrative procedures for review and evaluation. Procedural strategy and effective constitution of statements for various governmental levels. Means of obtaining sources of authoritative information. Fall and Spring. Mr. Black.

640. Analysis and Control of Forestry Operations **(3)**
Two hours of lecture, three hours laboratory. Applications of scientific methods to management decision problems of forestry operations with emphasis on data sources and reliability, model formulation, inventory control, equipment replacement, simulation, and critical path scheduling and costing. Fall. Mr. Sullivan.
Prerequisites: APM 491 or equivalent, ERM 373 and computer programming.

641. Soil and Water Conservation **(3)**
Three hours of lecture and discussion. An integrated examination of the many aspects of the field of water and related land resource conservation in the United States. Topics include the evaluation and present status of planning, organizational, economic and legal constraints on the development of policies and programs of the Federal agencies, state and local government and private units. Fall. Mr. Black.
Prerequisite: Permission of the instructor.

642. Water Quality Management **(3)**
Three hours of lecture and seminar per week. The review of the ethical, historical, legal and technical basis for water quality management. Investigation of public policy on the international, Federal, state and local levels and the administrative methods and programs used to implement policy. Fall. Mr. Hennigan.

643. Urban Water Management **(3)**
Three hours of lecture and seminar per week. A review of the role of urban water management in water resources management. The problems and issues of providing water utilities services of water supply, drainage and waste water facilities including such considerations as planning, financing, local government, intergovernmental relations, state and Federal role, water institutions and applicable law. Spring. Mr. Hennigan.

650. Forestry and Economic Development **(3)**
Three hours of lecture and discussion. Study of the role of forest resources in the process of economic development. Characteristics of forest resources which are important for economic development are analyzed in detail. Interrelationships between biological,

technological and institutional factors are stressed. Fall. Mr. Petriceks. Offered to seniors and graduate students in environmental and resources management. Open to others by permission of instructor.

Prerequisite: ERM 463 or its equivalent.

662. Land Use Economics **(3)**

Three hours of lecture/discussion per week. Study of the theory and methods of land use economics and the application of economic analysis to open space and regional planning. Emphasis is on understanding basic concepts, developing of operational methods and data sources. Case studies, outside readings, and guest speakers are utilized. Fall. Mr. Canham.

Prerequisite: One course in macroeconomics and one in microeconomics and permission of instructor.

670. Economics of Nonmarket Goods **(3)**

Group discussion, lectures, guided readings, case studies and student projects on the economic aspects of watershed management, fish and wildlife management, and outdoor recreation. Major topics include theories of valuation and application to nonmarket goods, cost analysis for nonmarket goods, and measurement of regional impacts. Spring.

Prerequisites: ERM 204 or 206 or equivalent, knowledge of basic statistical analysis, and six hours or more of resource management coursework.

672. Open Space Planning (Recreation) **(3)**

Three hours of lecture/discussion per week. Study of methods and techniques applicable to open space planning in nonurban areas. Survey of literature and current research. Open space standards, classification systems and inventory methods. Development of plans for large scale recreation areas, and inclusion of recreation into regional plans. The interrelationship and conflicts between resource utilization/development and recreation/aesthetics reviewed through case studies. Fall. Mr. Gratzer.

Prerequisite: One course in outdoor recreation, one course in planning, and permission of instructor.

675. Social Psychology of Leisure Behavior **(3)**

Three hours lecture and discussion. Introduction to theory and research findings dealing with the sociological and psychological aspects of leisure behavior: field work and lectures demonstrate applications, particularly in outdoor recreation. Spring. Mr. Morrison.

710. Advanced Principles of Forestry Economics I **(3)**

Two hours of lecture, two hours of discussion. Intensive study of the microeconomics of forestry. Offered only to graduate students. Fall. Staff.

711. Advanced Principles of Forestry Economics II **(3)**

Two hours of lecture, two hours of discussion. Intensive study of the macroeconomics of forestry. Offered only to graduate students. Spring. Staff.

732. Research Methods **(3)**

Instruction regarding methodology in the approach to and solution of problems in Forest Management research. Restricted to graduate students in Forest Management. Spring. Staff.

751. World Forestry **(3)**

Three hours of lecture and discussion. World forest distribution and types; regional production and consumption of forest products; international trade in timber and related products; the role of forest resources in development; and special topics; tropical forestry, comparative forest policies and programs, forestry education, the problems of developing countries, international cooperation in forestry development, the role of the United States in world forestry, etc. Fall or Spring. Staff.

Prerequisite: Graduate status.

752. Applied Forest Management **(3)**
Principles and practices of forest management as applied to specific forest properties under the guidance of responsible public and private foresters. Several days are spent in the field studying forest conditions, organizations, operations, and problems. By observing actual forest operations, students become acquainted with the latest and most efficient forest practices in office and forest. Fall. Mr. Horn.

753. Resources Policy **(3)**
Three hours of lecture and seminar. Evaluation of basic environmental and resource issues and their evolvement in public and institutional policies. Exploration of alternative resource goals, policies, and program approaches and their implications. Analysis of processes for policy delineation and modification. Fall. Mr. P. F. Graves.

754. Advanced Forest Administration **(3)**
Critical appraisal of existing public, semi-public and private forestry agencies in the United States, and the comparative study of major administrative organizations and practices. Occasional inspection trips to forestry headquarters and field units and discussion of internal administrative problems with forest officers. Spring.
Prerequisite: ERM 460 or equivalent.

756. Management Concepts in Planning Forest Production **(3)**
Three hours of lecture and discussion. The theories and principles involved in planning the annual allowable cut and the resulting yearly cutting schedules. The influence of technical decision and socioeconomic pressures upon the level of cutting and the effect of the level of cutting upon the dependent industry. Fall or Spring. Mr. Koten.
Prerequisite: ERM 476 or equivalent.

797. Seminar **(1)**
Group discussion and individual conference concerning current topics, trends and research in management. Fall and Spring. Staff.

798. Research Problems in Resources Management and Policy
(Credit hours arranged according to nature of problem)
Special investigation and analysis of resources management problems where integrative relationships of several subject aspects of forestry are a major consideration. Fall and Spring. Staff.

800. History of Economic Thought in Forestry **(3)**
Three hours of discussion or conference. Systematic study and critique of the development of the thinking of foresters and economists with respect to some segment of the subject matter of forestry economics. Review of major individual contributions to thought and the influence of leading scholars upon the thinking of others. Appraisal of the leading schools of thought. Offered only to graduate students. Fall or Spring. Mr. Bennett.

840. Professional Workshop in Forestry Economics **(3)**
Two hours of seminar and one three-hour laboratory each week. RMP 840 is an internship-workshop in the interpretation of forest economics. The seminars are devoted to problems of programming, materials, instruction, testing, and evaluation. The laboratory incorporates leading a one-hour discussion group in ERM 206 with preparation for that discussion group and with the writing of a report on the laboratory to be used in a subsequent seminar meeting. Fall. Mr. Bennett.
Prerequisites: Econ 605, Econ 606, or permission of instructor.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

SILVICULTURE (SIL)

553. Energy Exchange at the Earth's Surface (3)
Two hours lecture and three hours of laboratory. A comprehensive study of the physical processes taking place in the lowest layer of the atmosphere. Primary emphasis on the turbulent transfer of heat, momentum and water vapor and the expression of these fluxes in the microclimate. Spring. Mr. Herrington.
Prerequisite: ERM 452, physics, and calculus.

625. Productivity of Forest Stands (3)
Examination of forest tree and stand production variables as related to silvicultural manipulation. Analysis of stand response, such as rate of growth, stem form, product quality, tree quality and value. Preparation of stand treatment schedules. Spring. Mr. Richards and Mr. Johnson.
Prerequisite: Permission of instructor.

640. Advanced Wildland Hydrology (3)
Lecture, discussion and laboratory sessions in advanced problems of forest and range hydrology, watershed management methods and techniques and evaluation of new methods of hydrologic data collection and analysis. Fall. Mr. Black.
Prerequisites: ERM 440 or FEG 340.

641. Watershed Analysis (3)
One hour of lecture and six hours of laboratory each week. Lecture and field experience in watershed characterization, inventory, and analysis in terms of land management problems. Fall. Mr. Black.
Prerequisites: ERM 440 and permission of instructor.

642. Snow Hydrology (3)
Three one-hour lectures per week and two three-day field trips. Physical characteristics of snow and the energy relations important in its accumulation and dissipation. Problems of measurement and prediction of runoff and melt. Potentials for management. Spring. Mr. Eschner.
Prerequisite: ERM 440 or FEG 340.

677. Advanced Forest Tree Improvement (3)
Two hours lecture and discussion, three hours laboratory. A study of advanced principles and techniques for genetic improvement of forest trees. Special emphasis is placed on selection and breeding for growth rates, wood quality and insect and disease resistance. Problems of tree hybridization, racial variations, sexual reproduction, and quantitative genetics in forest trees. Laboratory training in cytology and cytogenetics, pollen germination, vegetative propagation and other problems. Independent research problems will be undertaken by the student. Fall or Spring. Mr. Westfall.
Prerequisites: FBL 370 and 371, ERM 455.

730. Research Methods in Silviculture (3)
Three hours of lecture or discussion. Research concepts and methodology with particular application to silviculture and its related sciences. More appropriate to beginning students or before taking thesis work. Fall. Staff.
Prerequisite: Permission of instructor.

735. Forest Soil Fertility (Applied Studies) (2-4)
Two hours of lecture, one hour of discussion. Up to six hours of laboratory depending on number of credit hours. Influence of soil fertility on development and growth of seedlings and trees, and techniques involved to determine this influence. Chemical and biological analysis to determine levels of soil fertility. Nutrient element deficiencies and their correction by soil amendments and fertilizers. Term projects by the student will be undertaken. Spring. Mr. Leaf.
Prerequisites: CHE 332 and 333, FBO 530, ERM 446, or equivalent.

737. Forest Soil Physics **(4)**
Three hours of lecture and discussion and three hours of laboratory. Presentation of principles of soil physics including water flow, storage and availability, soil permeability, heat transfer, and their consideration as root environmental factors. Analytical procedures are introduced and evaluated. Applications of soil physics to silvics, soil fertility, watershed management and hydrology, soil biology and land-use. Spring. Mr. Craul.
Prerequisites: ERM 345, 446, or their equivalents. Physical chemistry and integral calculus strongly recommended.

777. Quantitative Genetics in Forest Tree Improvement **(3)**
Two-hour lecture and discussion, three hours laboratory. Development of statistical models for determining heritability in forest trees. Breeding models and computer analysis application in forest genetics. Fall or Spring. Mr. Westfall.

797. Graduate Silviculture Seminar **(1)**
Three-hour class discussion per week. Assigned reports and discussion of silvicultural topics. Fall and Spring. Staff.

798. Research Problems in Silviculture
(Credit hours arranged according to nature of problem)
Hours to be arranged. Fall and Spring. Staff.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

WOOD PRODUCTS ENGINEERING (WPE)

596. Special Topics **(1-3)**
Lectures, conferences, discussions and laboratory. Special topics in Wood Products Engineering including techniques in scientific photography, microscopy, laboratory instrumentation, and computer applications as well as other topics of departmental interest. Fall and/or Spring. Staff.
Prerequisite: Consent of instructor.

666. Wood-Water Relationships **(3)**
Two hours of lecture, three hours of laboratory. Consideration of basic wood-water relationships and the drying of lumber and other wood products. Fall. Mr. Skaar.
Prerequisites: Physics, calculus, WPE 326 or equivalent.

688. Commercial Timbers of the World **(3)**
One hour of lecture, one hour of conference, three hours of laboratory, and assigned reading. Important commercial timbers of the world, their structure, physical properties, identification, supply and uses. Spring. Mr. DeZeeuw.
Prerequisite: WPE 387.

796. Advanced Topics **(2-3)**
Lectures, conferences, discussions, and laboratory. Advanced topics in Wood Products Engineering including techniques in scanning and transmission electron microscopy, laboratory instrumentation, and computer applications as well as other topics of departmental interest. Fall and/or Spring. Staff.
Prerequisite: Consent of instructor.

797. Wood Products Engineering Seminar **(2-3)**
Conference, discussion and reports analyzing current research and new developments, new literature and subject matter surveys in wood products engineering. Fall and Spring. Staff.

798. Research in Wood Products Engineering
(Credit hours arranged according to nature of problem)
Investigations on directed study in wood products engineering including manufacturing, marketing, anatomy, physics, quality, and mechanical properties of wood. One typewritten report (original and one carbon) required. Fall and Spring. Staff.

880. Interpretation of Cellular Ultrastructure **(2)**
One hour of lecture, two hours of demonstration and discussion. The organization and sculpturing of the walls of plant cells; the cellulose microfibril, matrix and incrusting substances, and the warty layer. The ultrastructure and general function of cytoplasmic organelles in cells. The tools and techniques used for light and electron microscopic study of cells, and the interpretation of structural evidence. Directed study and discussion of the latest (current) literature on pertinent topics. Spring. Mr. Cote.
Prerequisite: Permission of the instructor.

899. Master's Thesis **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

Index

Admission Procedure 9
Admission Requirements 9
Assistantships 13

Biology, Chemistry and Ecology,
School of 18
Botany and Forest Pathology 18

Calendar, Academic 2
Chemistry 22
Costs 11
Course Offerings 41

Degrees, Doctoral 8
Degrees, Masters 7
Degree Programs 17
Degree Requirements 7

Economics, Forestry 33
Employment 15
Engineering, Forest 24
Entomology 19
Environmental Communications . 30
Environmental and Resource
Engineering, School of 29
Environmental and Resource
Management, School of 29
Environmental Science 17

Faculty 5
Fellowships 13
Financial Assistance 13
Fish and Wildlife Management ... 30
Forest Influences 30
Forest Management 30

Graduate Record Examination 9

Housing 11

Insurance 11
Interdisciplinary Degree
Programs 17, 36
International Forestry 30
International Students 10, 14

Land Use Planning 32
Landscape Architecture,
School of 34
Loans, Educational 14

Management, Forest 31
Management, Recreation 32
Multidisciplinary Degree
Programs 17, 36

Numbering System (for courses) . 41

Organic Materials Science 36

Paper Science and Engineering .. 25
Policy and Administration 33

Quantitative Methods 31

Recreation Management 32
Research 5
Residence Requirements 7, 8
Resource Management and Policy . 30

Scholar Incentive Program 14
Scholarships 13
Silvics 30
Silviculture 30
Soil Science 30

Tuition and Fees 11
Tuition Waivers 14

Water Resources 37
Wood Products Engineering 27
World Forestry 38

Zoology, Forest 20

COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY
SYRACUSE, NEW YORK 13210

:HEMISTRY ★ BIOLOGY ★ BIOMETRY ★ BOTANY ★ BUILDIN(
STRUCTION ★ CELLULAR ULTRASTRUCTURE ★ CHEMICA

RSNorth

Graduate Studies

State University of New York COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

1976

LOGY ★ CHEMISTRY ★ ECOLOGY ★ ECONOMICS ★ ENGINEERING ★
OMOLOGY ★ ENVIRONMENTAL STUDIES ★ FIBER PHYSICS ★ FOREST
HNOLOGY ★ LAND USE ★ LANDSCAPE ARCHITECTURE ★
NOLOGY ★ MATERIALS MARKETING ★ METEOROLOGY ★
ROSCOPY ★ MYCOLOGY ★ NATURAL PRODUCTS ENGINEERING ★
RATIONS RESEARCH ★ ORGANIC MATERIALS SCIENCE ★ OUTDOO
REATION ★ PAPER ENGINEERING ★ PAPER SCIENCE ★ PATHOLOGY ★
TOGRAMMETRY ★ PHYSIOLOGY ★ POLYMER CHEMISTRY ★
DUCTION SYSTEMS ENGINEERING ★ REGIONAL PLANNING ★
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TER RESOURCES ★ WILDLIFE ★ WOOD PRODUCTS ENGINEERING ★
)D SCIENCE ★ WORLD FORESTRY ★ ZOOLOGY ★ BIOCHEMISTRY ★

CORRESPONDENCE DIRECTORY

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The calendar, courses, tuition and fees described in this Bulletin are subject to change at any time by official action either of the State University of New York Board of Trustees or of the College of Environmental Science and Forestry.

State University of New York

COLLEGE OF

ENVIRONMENTAL SCIENCE AND FORESTRY

1976—77

Graduate Studies Bulletin

TABLE OF CONTENTS

Academic Calendars	2
ESF: What's In A Name?	5
The Mission: Instruction, Research, Public Service	8
The Campuses	15
The Syracuse Metropolitan Area	21
Graduate Study At ESF	23
Requirements For Degrees	25
Admission	27
Expenses	29
Financial Assistance	31
Graduate Degree Programs	35
Course Offerings	59
State University Of New York	87
College Trustees And Administration	91
College Faculty And Professional Staff	93
Index	108
Campus Locator And Map	110

Academic Calendar

SYRACUSE CAMPUS

FALL 1976

Registration	September 8-9	Wednesday-Thursday
First Day of Classes	September 10	Friday
Yom Kippur (no classes)	October 4	Monday
Thanksgiving Vacation	November 24-28	Wednesday-Sunday
Last Day of Classes	December 15	Wednesday
Reading Day	December 16	Thursday
Exam Period	December 17-23	Friday-Thursday

SPRING 1977

Registration	January 17-18	Monday-Tuesday
First Day of Classes	January 19	Wednesday
Spring Recess	March 12-20	Saturday-Sunday
Last Day of Classes	May 3	Tuesday
Reading Day	May 4	Wednesday
Exam Period	May 5-11	Thursday-Wednesday
Commencement	May 14	Saturday

ESF: What's In A Name?

1911. Governor John A. Dix signed a bill establishing the New York State College of Forestry at Syracuse University.

1948. Legislative action incorporated in State University of New York all state-supported higher education. Thus, the State University College of Forestry at Syracuse University.

1972. By special legislative act, the College was renamed the State University of New York College of Environmental Science and Forestry.

Why, in the first place, all the name changes? And, secondly, what difference do they make? What, really, is in our name?

ESTABLISHING A TRADITION

While a professional forestry education in this country is almost entirely a development of the twentieth century, its primary roots can be traced back as early as 1862 when Congress passed the Morrill Act establishing a system of land-grant colleges.

The growing importance of forests in America's economy was reflected in the 1870 Census, when, for the first time, information on forest resources was included. Several attempts to establish a national school of forestry were made; while none was approved, the movement shows that there was considerable demand for professionally trained foresters.

By 1900 there was a spirit of reform in the country—the same spirit that produced the early muckrakers also produced a generation interested in the conservation, preservation and careful management of precious natural resources. Between 1903 and 1914, 21 schools of forestry were established.

The first college of forestry in this country to offer a full, four-year undergraduate program was established in 1898 at Cornell University. Under the leadership of Bernard E. Fernow, students were introduced to critical field experience in their junior and senior years at the college's 30,000-acre forest in the Adirondacks. There, Fernow taught many experimental management practices, including clear-cutting and surface-burning. These techniques have always been controversial, and they aroused criticism by the wealthy summer residents in adjacent areas of the Adirondacks. After only five years of operation, the Cornell College of Forestry was closed in 1903 when the State Legislature, yielding to the influential property owners, ended fiscal support.

The beginnings and early development of the New York State College of Forestry were largely due to James R. Day, Chancellor of Syracuse University, and community leaders who were attuned to the growing national sentiment favoring forest conservation and who sensed the need for a professional school of forestry. The legislative act which created the College instructed that the institution "conduct such special research in State-wide investigations in forestry as will throw light upon and help in the solution of forestry problems. . ." and that it be "the institution for educational work in forestry in the State."

From the very first years of its existence under the first dean, Hugh P. Baker, the College responded to the broad needs of environmental professionalism. While other schools and colleges of forestry became more specialized, the College at Syracuse broadened to include the essentials of environmental science: design, engineering and the life sciences, as well as resource management.

BROADENING THE BASE

With the formation of the State University of New York in 1948, coordination and systematization came to higher education in the state. The University, according to its charter, was to "supplement, not supplant, the great network of private colleges and universities." The College of Forestry which, from its beginning had been state-supported and governed by a Board of Trustees made up of eight members appointed by the Governor and four *ex-officio* members, was recognized as a specialized college within the State University system.

Stemming from Chancellor Day's early sponsorship of the College, Syracuse University and ESF have long been engaged in numerous fruitful devices of institutional cooperation. This relationship is probably the most outstanding example in this country of collaboration between public and private institutions of higher education. Even as a part of State University, the College maintains this unique position. The major character of the relationship stems from the fact that the College purchases from Syracuse University the major portion of its lower division instruction, thus allowing the College to more fully develop its professional senior division and graduate level instruction.

Other cooperative areas are living centers and dining facilities, athletic programs, the use of the University's infirmary and health counseling services, the bookstore facilities, the University library system and participation in numerous social activities including the elaborate religious, dramatic and cultural benefits of a large university.

Since the early days of the College, every graduate—whether he is awarded a baccalaureate, master's or doctoral degree—receives two diplomas, one from the College and one from Syracuse University. Indeed, the commencement exercises are held jointly. Upon graduation, students become alumni of the College and also of Syracuse University.

ESF TODAY

The third phase in the evolvement of the College's name came in 1972 when it was rechartered as the State University of New York College of Environmental Science and Forestry. Thus, the name reflects more deeply the traditional grounding and concern of forestry in the environment; it illuminates more clearly the capabilities of its program.

For over 60 years, the full thrust of the State University of New York College of Environmental Science and Forestry has been focused on the environment on all of its six campuses and in each of its three mission areas—instruction, research and public service. The College has been, and continues to be, devoted to the advancement of environmental science and forestry.

The Mission: Instruction, Research, Public Service

INSTRUCTION

Professional Education

In the Fall of 1975, student enrollment reached 2,491. Of this number, 2,039 were undergraduates and 452 were graduate students. In addition, there were 24 students engaged in postdoctoral work.

At the baccalaureate level, the College offers professional study in seven four-year curricula: *biology; chemistry* (with options in biochemistry and natural products or natural and synthetic polymer chemistry); *forest engineering; paper science and engineering* (with options in paper science or paper engineering); *wood products engineering* (with options in wood science, building construction, production systems engineering or materials marketing); *resource management;* and *landscape architecture.*

Each of these curricula leads to the bachelor of science degree. In the case of landscape architecture, an additional year of study results in a bachelor of landscape architecture degree; and in the forest engineering program, a fifth year leading to a bachelor's degree in civil engineering can be taken at Syracuse University or State University at Buffalo.

Several curricula allow students to minor in environmental studies, applied management, urban forestry, regional planning, world forestry, conservation education and communications, management science and forest resources science.

Graduate Education

The College awarded its first graduate degree in 1913. Today, the College offers programs in 12 major disciplinary and interdisciplinary areas: *environmental science, botany and forest pathology, entomology, forest zoology, chemistry, paper science and engineering, wood products engineering, forest engineering, forestry economics, forest management, silviculture and landscape architecture.*

Graduate study leads to the master of science degree and the doctor of philosophy degree. A postdoctoral study program, closely related to the College's research effort, is also available.

Technical Education

At the paraprofessional level, the College has been training forest technicians since 1912 at its Wanakena Campus in the Adirondack Mountains. It is the oldest Ranger School in the United States.

In 1973 a two-year *forest technology* curriculum replaced the one-year certificate program. Graduates are awarded an associate in applied

science degree. In the new curriculum, students take their first year of general education either at the College's main campus in Syracuse or at an accredited junior college. The second year, with its emphasis on practical field training on the relationships between forest technology and managerial needs, is taken at Wanakena with its 2,800 acres of forested land. Graduates of this degree program in practical forestry are prepared for positions as forest rangers; federal, state and private industry forest technicians and forestry aides; company district forest supervisors; timber inventory specialists; timber sales supervisors; forest surveyors and engineering aides; and forest protection technicians.

Continuing Education

The philosophy that education is a lifelong pursuit is an ancient one and was written into the law creating the College. This concept is doubly important to the sciences and professions in this technological age when, with new knowledge bursting in all directions, major environmental problems still remain to be resolved. The informational needs of New York's citizens also are undergoing change. The increasing urban character of our population, the changing pattern of agricultural and forest land ownership and use, the rise in level of education and sophistication in a more efficient society, and the increase in leisure time, travel mobility and need for recreational facilities and pursuits all contribute to a growing need for educational opportunities in the environmental sciences and forestry for adult audiences.

The College has, over the years, succeeded in communicating knowledge on forest resources management, utilization and conservation to a wide variety of off-campus publics. The entire College faculty has contributed to these programs. To reinforce this commitment, the College established a School of Continuing Education upon which to base expanded educational opportunities at both the undergraduate and graduate course levels.

Conferences, symposia, seminars and short courses on various aspects of forestry and the related sciences are conducted at both the basic and applied levels. Audiences include forest owners, managers and operators; wood engineers and forest industries personnel; academic and scientific groups, conservation and recreation personnel from local and other public and private planning groups and citizen-action committees. Upon request, special continuing education programs can be designed to meet the specific needs of professional organizations, agencies and industry. Credit or non-credit courses, at campus or off-campus sites, can be arranged.

Expansion of "in-service" training courses, establishment of "environmental learning centers" on College forest properties and production of media materials for public information and education are examples of activities directed toward updating and upgrading professional clients and broadening the public's awareness and appreciation of New York's forest-lands and other natural resources.

For information on specific continuing education projects, inquiries should be sent to Dean, School of Continuing Education.

RESEARCH

The College's commitment to scientific inquiry stretches far back to its second year of existence. In 1912, Dean Hugh P. Baker initiated the first research project of the College by joining forces with the U.S. Forest Service in an industry study designed to show what kinds of firms were using wood in New York State and the species and quantities of lumber they used.

In the 1970's, the College's research program has attracted a world-wide clientele of industrial, governmental, professional and scientific groups, and through liaison with them, the program maintains its vigor and relevancy to the important environmental issues of the decade.

Support from this clientele currently amounts to about $2.5 million a year.

Students and faculty from all disciplines contribute to the depth and diversity of the research program. Their findings are transferred into professional practice applications by the College's demonstration and information function. Recent examples of the program include land use studies for the New York State Commission to Study the Tug Hill; fish and wildlife studies for the New York State Commission to Study the Catskills; the development of polymeric materials for artificial human organs; non-chemical alternative control measures for destructive insect pests like the gypsy moth; and new pulping processes leading to pollution-free water and air effluents.

The Institute of Environmental Program Affairs

The Institute of Environmental Program Affairs (IEPA), created at the College in 1972, is an umbrella-like structure that coordinates the overall research effort of the College with the efforts of other academic institutions, public agencies and private industries for a concerted attack on compelling and complex environmental problems. IEPA culminates the College's ongoing examination of its appropriate role as a leader in environmental education for the 1970's and beyond in face of urgent appeals for multidisciplinary approaches, for problem-oriented task forces by both faculty and students, and for the greater application of higher education to society's needs. Because it is a process, the Institute preserves the identity of each collaborator: institutions, faculty members and students come together for just as long as necessary to solve a problem, then return to other ongoing areas of interest. Recent projects have included: regional resources and environmental studies for the St. Lawrence-Eastern Ontario Commission; studies of wetlands evaluation systems for the Adirondack Park Agency; a study of limestone quarry reclamation, sponsored by the Allied Chemical Corporation; and development of environmental impact assessment guidelines for the New York State Department of Environmental Conservation.

Applied Forestry Research Institute

Much of the research being conducted at universities and institutes, while of value to long-range scientific study and technological progress, is of limited, immediate application for forest practitioners. With this consideration, the Applied Forestry Research Institute (AFRI) was established in 1967 at the College with the cooperation of the New York State Department of Conservation. At the time of its founding, AFRI was charged with the task of carrying out research in the state that can be implemented at once by practicing foresters and forest resource managers.

The need for such research becomes more acute with time: the demands placed on the forest resource are ever increasing, and conservation groups are deeply concerned about the environmental impact of forestry's operations.

Practical research interests of AFRI include forest engineering (mechanized logging, woods and mill safety, and testing of timber harvesting techniques and equipment; hardwood and conifer management; forest protection (pest and disease control); and multiple land-use management.

Because of its location on ESF's main campus, AFRI has access to the College's extensive research equipment and instruments, including electron microscopes, plant growth chambers, photogrammetric facilities and computer center.

There is close cooperation with the College's highly competent teaching-research faculty who provide the latest information about basic research findings by disciplines as well as supporting technical information and techniques. This liaison allows for the exchange of views between the academician and the field practitioner.

AFRI is supervised by a director, and has a staff of nine full-time research associates and two technical assistants.

Empire State Paper Research Institute

The Empire State Paper Research Institute (ESPRI), located on the main campus, is the only world-wide basic research organization in the pulp and paper field. It performs investigations in cooperation with the Empire State Paper Research Association (ESPRA), which is comprised of 62 pulp and paper companies in 11 countries. The Institute was established in 1945 when the members of ESPRA recognized the need for new scientific and technical knowledge and methods, and since then ESPRI has been able to maintain an efficient balance between the practical and theoretical bases of the pulp and paper industry.

Housed in the modern J. Henry Walters Hall with its own pilot paper mill, and staffed by scientists who are internationally recognized for their accomplishments, ESPRI provides a research base for long-range industry development. Its program has widened in scope to cover almost all aspects of pulping and papermaking, including additive retention, oxygen pulping and bleaching, effluent control, sheet drying and printability.

State University Polymer Center

In 1966 the College's polymer research institute was designated as the State University of New York Polymer Research Center in order to stimulate University-wide interest in polymer chemistry.

Scientists at the College have made many original contributions to the field of pure and applied polymer chemistry, including the development of living polymers, the study of anionic polymerization and electron-transfer initiation, and work on the permeation of gases and films through polymeric films.

College faculty members specializing in polymer chemistry have trained several hundred graduates and postdoctoral researchers, many of whom now hold leading positions in universities and industrial and governmental laboratories.

U.S. Forest Service Cooperative Research Unit

The Northeastern Forest Experiment Station of the U.S. Forest Service maintains a center for recreation research at the College. Forest Service personnel collaborate directly with faculty and students on research projects in this new area of resource management in order to develop methods for evaluating the quantitative and qualitative aspects of recreation demand and their relationship with multiple-use forest management problems.

Among the many undertaken areas for investigation are a leisure-time use study of Onondaga County residents and a project to determine aesthetic preferences for various types of timber harvesting practices.

Nelson Cortlandt Brown Laboratory for Ultrastructure Studies

This center, located in Baker Laboratory, is a teaching, research and service facility of the College. It is equipped to handle virtually every type of modern microscopy operation, including light, scanning electron and transmission electron. Among the major items of equipment are: an RCA EMU-3 transmission electron microscope; an RCA EMU-4, an ETEC autoscan scanning electron microscope, several types of light microscopes, high vacuum evaporators and microtomy equipment.

The primary service of the center is teaching; course offerings include microtechnique, photomicrography, electron microscopy and interpretation of cellular ultrastructure. A second function of the center is to provide research on a service basis to faculty and students and to the community at large.

PUBLIC SERVICE

The College, throughout its 65-year history, has continued to respond to its specific legislative mission prescribing major responsibilities in the area of public service. Public education and information, technical advice and guidance to cooperating local, state and federal agencies and organizations, and technical assistance to the forest and wood-using industries constitute the principal formal public service activities. The Institute of Environmental Program Affairs (described in the Research section) coordinates the College's public service activities on the professional level.

While the list of public service contributions is lengthy, a few other examples include: the College's Film Library; the Tree Pest Service, which provides technical advice to private citizens and to governmental agencies; the participation of ESF faculty members in Central New York's Poison Control Center; and membership in PACE (Planning Approaches for Community Environments), a faculty-supervised student design and planning service to benefit community development. Altogether, the public service programs of the College reach approximately one million New York State residents each year.


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110 90 70 50 30 10 10 30 50 70

The Campuses

The College has a multiple campus system with regional campuses and field stations located at Syracuse, Tully, Wanakena, Warrensburg, Cranberry Lake, Newcomb and Clayton. This system is composed of about one million square feet of facilities and 25,000 acres of land. Collectively, they represent the largest fully utilized campus in the world.

THE SYRACUSE CAMPUS

The main campus is in Syracuse, and lies on 12 acres adjacent to Syracuse University, in an area that traditionally has been known as "The Hill." Located here are the Schools of Biology, Chemistry and Ecology; Environmental and Resource Engineering; Environmental and Resource Management; Landscape Architecture; and Continuing Education. In addition, the main campus houses the Institute of Environmental Program Affairs, the Applied Forestry Research Institute, the Empire State Paper Research Institute, the State University Polymer Research Center, a cooperative research unit of the U. S. Forest Service, and an ultrastructure laboratory.

Specialized facilities at the Syracuse campus include electron microscopes, plant growth chambers, air-conditioned greenhouses, an animal environmental simulating chamber, a bio-acoustical laboratory, a 1,000-curie cobalt-60 radiation source, radioisotope laboratory, computer center, and specialized instrumentation including nuclear magnetic resonance spectrometer, electron spin resonance spectrometer, mass spectrometer, ultracentrifuge, X-ray and infrared spectrophometer. Photogrammatic and geodetic facilities of the forest engineering department include one of the most extensive arrays of equipment in the United States, with a Nistri TA-3 stereocomparator, Mann comparator, computerized Nistri photocartograph, and nine other varieties of plotters. The paper science and engineering laboratory has a semicommercial paper mill with accessory equipment. The wood products engineering department has a complete strength-of-materials laboratory as well as a pilot scale plywood laboratory and a machining laboratory. The greenhouses and forest insectary are used to produce plant and insect material for classroom and laboratory. Extensive collections are available for study, including wood samples from all over the world, botanical materials, insects, birds, mammals, and fishes.

The **F. Franklin Moon Library** contains more than 65,000 cataloged items. Over 800 journals and corresponding indexes are currently received. The collections constitute an information center for forestry and environmental science programs in ecology, botany and pathology, biochemistry, chemical ecology, forest chemistry, polymer chemistry, economics, entomology, environmental studies, industrial pollution abatement, landscape architecture, environmental design, management, paper science and engineering, photogrammetry, silviculture, soil science, water resources, world forestry, wildlife biology, wood products engineering and zoology. These are supplemented by large collections in the environmental resource field. Additional strength is found in the comprehensiveness of abstract and indexing services relevant to the College's programs. The library also offers a selected and broad choice of general-interest reading material.

The collections of Syracuse University Libraries and State University Upstate Medical Center are within walking distance. They may be used by all members of the College of Environmental Science and Forestry. Arrangements often can be made to use industrial libraries in the Syracuse area. Other collections are accessible through the Inter-library Loan privilege.

The library building, opened in 1968, can accommodate 132,000 volumes and can seat 575 persons. The main reading areas are in the center of the upper level surrounding open stacks, a current periodicals room, bibliographic center, individual study carrels and library staff offices. The archives, special collections, conference rooms, audio-tutorial center and informal study rooms are located on the lower level.

The audio-tutorial center provides facilities for study with nonbook materials. Slides and cassettes prepared as integral units of particular courses are held on reserve for use in the center. Materials are available for review on weekends, evenings and times when other facilities are closed.

Leisure reading material is distributed throughout the total collection which represent the Robin Hood and Raymond F. Crossman collections, and contain books on national and world social problems, humanities, education and popular books concerned with the environment. The archives consists of historical items relevant to the College and forestry developments in New York State. The special collections room contains rare and valuable books and folios.

Reference service, orientation and bibliographic instruction (Library Research 300) are provided by the librarians. Study guides, user aids and other such publications are prepared and distributed by the librarians as needed.

The **Educational Communications** unit directly supports the program areas of the College through development and application of media materials and methods for the classroom, for the presentation of research findings and for public service endeavors. These include television programming, slide/tape and motion picture production. Other services to the College community include engineering, A-V equipment distribution, and maintenance and support functions. The Educational Communications staff also participates directly and actively in instructional programs in environmental communication at both the undergraduate and graduate levels as well as through the School of Continuing Education.

The College's **Computer Center** has a Control Data 3200 computer system utilized in its academic and research programs, and to a moderate extent, for its administrative data processing needs. The instructional work consists of courses which teach the use of computers and those which use the computer to assist in teaching applied subjects. The major use is in the graduate programs where students perform research in areas such as hydrology, transportation networks, forest and tree growth studies, genetics, disease and insect behavior and controls, land use, production and processing techniques, polymer and cellulose chemistry, cellular ultrastructure, photogrammetry and remote sensing, landscape architecture, and other supporting and related fields.

THE TULLY CAMPUS

Located about fifteen miles south of Syracuse is the Tully Campus composed of the Heiberg Memorial Forest, classrooms and research facilities.

Heiberg Memorial Forest has a diversity of terrain and forest growth. There, planting from known seed sources from many parts of this country and throughout the world is utilized both as an extensive outdoor teaching laboratory and as a site for intensive research.

THE WANAKENA CAMPUS

The Wanakena Campus is located on the Oswegatchie River, 65 miles northeast of Watertown, New York and 35 miles west of Tupper Lake, New York. This campus supports the College's **School of Forest Technology**, the oldest forest technician school in the country, and its instructional and demonstration forest. It is on this campus that forest technicians are trained in an associate degree program.

THE WARRENSBURG CAMPUS

Each summer, the Warrensburg Campus hosts a program devoted to the field application of environmental principles and practices for students majoring in resource management and environmental biology. Formal continuing education courses also are held here for such groups as State foresters, mill owners and logging operators.

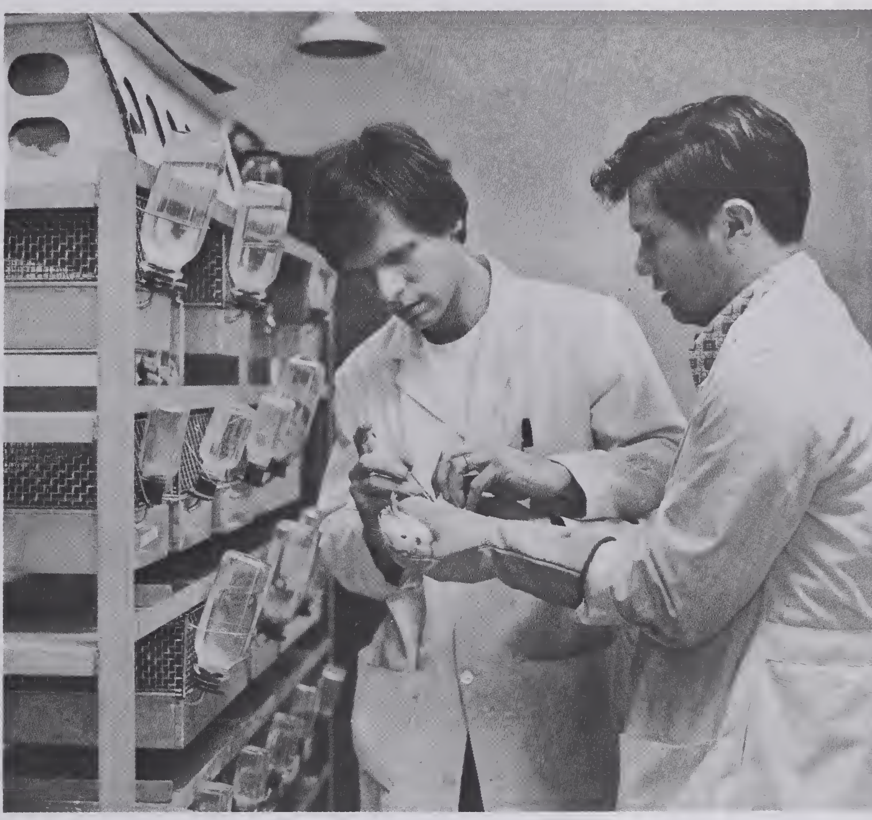
The Warrensburg Campus also contains the **Charles Lathrop Pack Demonstration Forest**, which, since 1927, has been under intensive management for the combined purpose of instruction, demonstration and research.

THE CRANBERRY LAKE CAMPUS

The Cranberry Lake Campus, accessible only by water, is the site of the College's biological station, where, every year, a cooperative program in environmental biology is sponsored jointly by the College and other institutions of higher education. Bounded by 150,000 acres of forest preserve, by Cranberry Lake, and by isolated forest bogs and beaver meadows, the extensive facilities are intensely utilized in a comprehensive curriculum of upper-level and graduate courses.

THE NEWCOMB CAMPUS

Located in the central Adirondack Mountains, Newcomb is the largest of the regional campuses and home to the **Adirondack Ecological Center**



where extensive studies of animal biology and ecology are carried out. Located there also is the **Archer and Anna Huntington Wildlife Forest**.

THE FIELD STATIONS

In addition to its Regional Campus System, the College operates several field stations which directly support the programs of the institution. The 44-acre **Forest Experiment Station**, located only a few minutes drive from the main campus, is used to support main campus academic programs. Located at the Station are a large arboretum, tree nursery and experimental greenhouse facility. Adjacent to the Tully Campus is the College's **Genetic Field Station**. With its irrigation system and layout of level blocks, it is an excellent facility for developing hybrids, for grafting experiments, and for research in heritability. A magnificent island, the **Ellis International Laboratory**, is situated in the heart of the Thousand Islands-St. Lawrence River area off the village of Clayton. Accessible only by water, this laboratory, which is the College's most recent property acquisition, is an unusually appropriate site for College-wide, cooperative and international environmental monitoring and research activities.


Larry's
PIZZA
SANDWICHES
TAKE OUT & DELIVERY
OUR SPECIALTY

The Syracuse Metropolitan Area

The College of Environmental Science and Forestry is located on one of several hills that overlooks Syracuse, a growing metropolitan area of nearly 500,000. Known as the "Salt City" because of the great salt industry which was centered here for more than seventy years, Syracuse is today a city of diversified industry and commerce. The area is a leader in the manufacture of china, quality shoes, air-conditioning equipment, medical diagnostic equipment and decorative home accessories.

The City of Syracuse offers students many cultural, recreational and educational opportunities, including a symphony orchestra, several museums, live theater and historical points of interest.

Called the "Crossroads of New York State," Syracuse is one of the few cities in the nation situated at the crossing point of two major superhighways. It is located at the intersection of the 500-mile New York State Thruway and the north-south Penn-Can Highway. Driving time from New York City, Philadelphia and Boston is about five hours; from Buffalo and Albany about three hours. The city is served also by a modern international airline and major bus and rail lines.

Graduate Study at ESF

Society is increasingly in the hands of those who have broad foresight and a balance of judgment in applying sociological and technical knowledge to guide human and environmental forces. Modern civilization—with its compelling demands from industry, government and educational institutions—requires persons who think objectively and constructively, and who act creatively and responsibly.

A purpose of the graduate years is to develop these persons. These years are a time of discovery and excitement, a time of answers and new insights, a time of personal productivity and contributions to scholarship. It is during the graduate education that the student develops the ability to think critically and analytically, to plan research, to design experiments, to work effectively with the basic research tools as well as specialized equipment, and to undertake the discipline of purposeful study toward a specific goal.

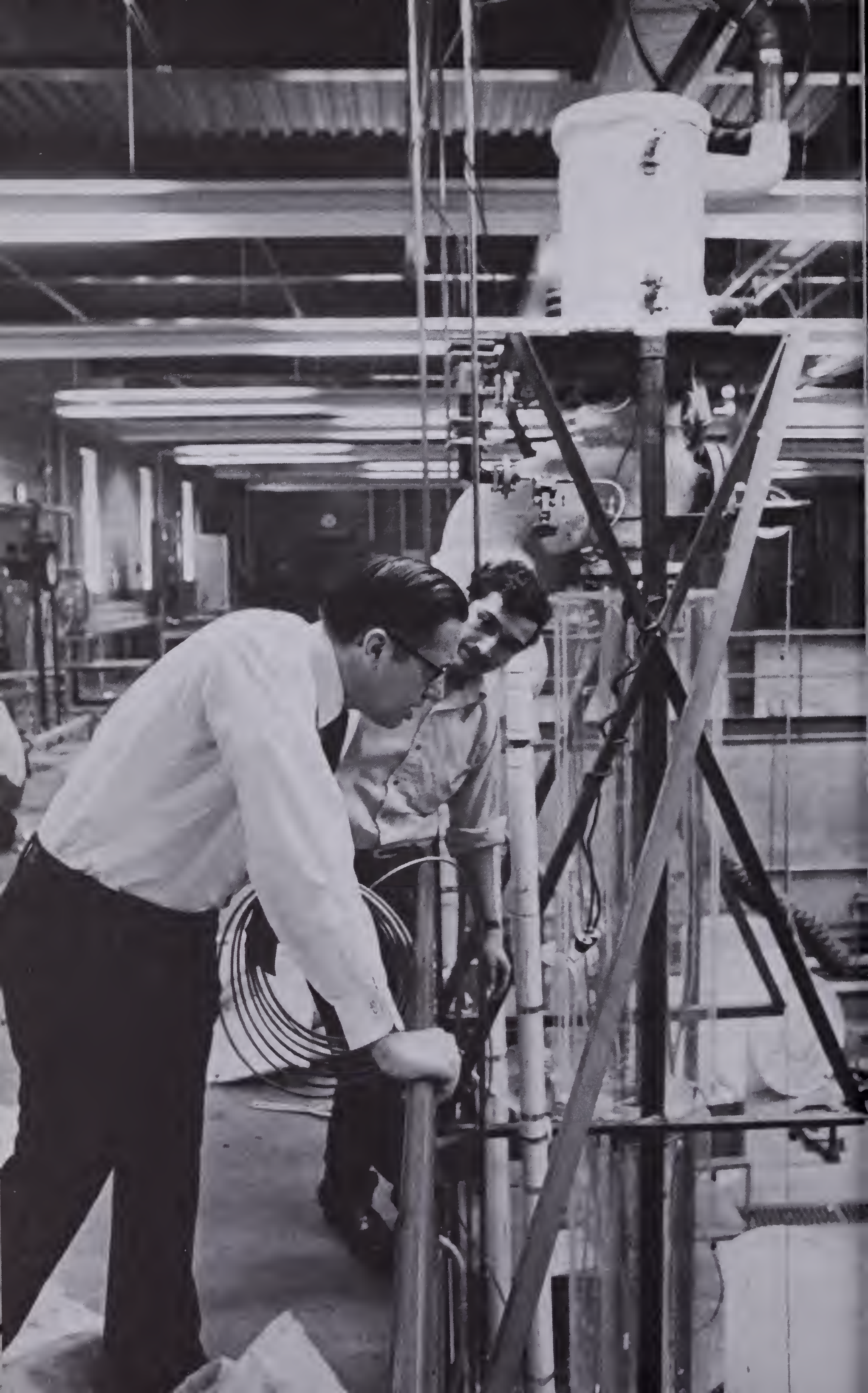
From its beginnings in 1911, the State University of New York College of Environmental Science and Forestry has served New York State and the nation in meeting the needs of its citizens in regard to the environment through education, research and public service. The faculty and students of the institution are committed to the resolution of immediate environmental problems, the development of the knowledge necessary to predict occurrences in the future, and the presentation of public policy alternatives that will both protect the environment and accommodate the real needs of society.

The major impetus for this inquiry lies in the research programs of the College in which the graduate students play an integral role with the faculty. The College has more than 150 faculty whose research interests in various aspects of environmental science involve more than 400 graduate students in master and doctoral degree programs.

The College currently supports significant graduate degree programs in eleven disciplinary subject areas and in addition, its broad program in Environmental Science encourages the development of multidisciplinary graduate research in several study areas.

The diversity and depth of the graduate programs of the College reflect the work of its excellent faculty and their graduate student colleagues utilizing some of the most modern facilities and laboratories in the country. They maintain a long-standing tradition of academic and professional excellence.

This bulletin provides an introduction to the College and its programs of graduate study and research. It only begins to suggest the diversity and depth of the exisiting and potential programs that make environmental science the *challenge of the 70's.*



Requirements for Degrees

Graduate programs are flexible and developed individually. Each program is planned by the major professor with the student to meet the individual's particular academic and professional needs. Sometimes this includes undergraduate courses for which no graduate credit can be given. In every case, emphasis is placed on outlining a study program leading to a high level of scholarly achievement.

An entire program for each student is planned and must be approved by the major professor, department chairman and School Dean. The program is modified as required upon recommendation of the major professor. A thesis committee composed of the major professor and two other faculty members is appointed early in each student's study program. In some departments, all graduate students are required to engage in an appropriate teaching assignment as an academic degree requirement.

THE MASTER'S DEGREE

All programs leading to the Master of Science (MS), Master of Forestry (MF) and Master of Landscape Architecture (MLA) degrees require at least 30 semester hours of graduate credit and two semesters in residence. From 6 to 18 hours of graduate credit may be earned through completion of a thesis or special project. The remaining credit hours are earned through completion of course work (passed with an average grade of B, or better). A total of at least 15 hours of credit, including thesis and special project credits, must be in courses numbered at the 600 level or above.

Acceptance of the thesis or special project depends on clear demonstration of ability to search and evaluate pertinent literature independently, to plan and carry through independent and important investigation, to interpret the significance of findings, and to present the subject in a well-organized, lucid and scholarly thesis. The student must also pass a final oral examination in thesis defense and demonstration of knowledge or related subject areas.

THE DOCTORAL DEGREE

Quality of work is especially emphasized for the doctor of philosophy degree. The student is required to penetrate the frontier of knowledge in the particular field of study and make a definite contribution to this knowledge. The student is also required to demonstrate original scholarship of a high order in the search and evaluation of literature, in the planning, execution and interpretation of scholarly research, and in the presentation of the findings in a thesis. Subsequent publication in a scholarly journal is expected.

There is no minimum credit hour requirement for the Ph.D. Each student must pass a qualifying examination before being admitted to candidacy. This two-part examination consists of a preliminary examination taken early in the period or residence to assist in planning a course work and independent study program, and a written and oral comprehensive examination to test breadth and depth of knowledge. There is no College-wide language requirement. However, competence in a foreign language, statistics, computer programming or other "tools" may be required where they are relevant to the student's field of study. A candidate for the Ph.D. degree with only a bachelor degree must be in residence for at least two full academic years. A candidate having a master's degree must be in residence for at least one full academic year. The final requirement is the presentation and defense of the Ph.D. thesis or dissertation which must represent an original contribution to knowledge.

Admission

REQUIREMENTS

The College of Environmental Science and Forestry, since its founding, has continually practiced open and competitive admissions regardless of race, color, sex, religion, national origin, handicap, or age. Pursuant to Title IX of the Education Amendments of 1972 and accompanying regulations: No person shall be denied the benefits of or be subjected to discrimination under any academic, extra-curricular, research, occupational training or other educational program or activity operated by this institution.

Admission to graduate study may be granted only to applicants with at least a bachelor's degree from a recognized institution, and whose preparation has been suitable in quality and content for the proposed field of major study. Applicants will be evaluated on the basis of the following: (1) their academic record should show at least a B or 80 percent average for the junior and senior years; (2) Graduate Record Examination Aptitude scores, and, in some cases, subject matter (advanced) tests indicative of graduate study ability (see below); (3) supporting letters of recommendation; (4) a statement of specific educational and professional goals which describes the choice of degree program and the students' plan for the pursuit of the objectives in the program; and (5) where appropriate, other evidence of scholarly achievement and potential. Admission is selective with priority given to applicants who have high scholastic standing.

ADVANCED TESTS

Subject matter (advanced) test scores are required by the following programs:

Graduate Programs	*Advanced Test*
Chemistry	Chemistry
Forest Botany and Pathology	Biology
Forest Entomology	Biology
Forest Zoology	Biology

PROCEDURE

All applicants are required to submit Graduate Record Examination aptitude scores. This examination is offered several times each year in major cities of the world. For information on registration and scheduling write to the Educational Testing Service, Princeton, New Jersey 08540.

Test scores should be sent to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210 (Institutional number R2530).

The College provides a special form for application for graduate work. Requests for information and applications should be addressed to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

INTERNATIONAL STUDENTS

Citizens of other countries with special educational objectives are accepted for graduate study in all programs. They must show satisfactory evidence that they have completed studies in their major field equivalent to those at a recognized American institution with a scholastic record equivalent to a B average in their junior and senior years. They must submit Graduate Record Examination scores as explained in the section on Admission Requirements. Also, applicants whose native language is other than English must submit scores on the Test of English as a Foreign Language (TOEFL). This requirement may be waived if the student has received a degree from an American institution. This examination is offered several times each year in major cities of the world. For information on registration and scheduling, write to the Educational Testing Service, Princeton, New Jersey 08540, U.S.A. In submitting test scores, request that they be sent to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

Expenses

TUITION AND FEES

The tuition and fee structure at the College includes library, health, infirmary, physical education, special testing and other services, as well as an assessment for student activities and charges for expendable supplies and equipment.

Graduate tuition for New York State residents is $700 per semester. Nonresident tuition is $900 per semester. All graduate students pay activity fees of approximately $28 per year.

COMMENCEMENT FEE

Candidates for both master's degrees and doctoral degrees pay a $10 commencement fee. Additional costs are incurred for the binding, abstracting, and microfilming of theses and dissertations.

HOUSING

The College does not operate student residences. These facilities are offered by Syracuse University, and cost varies according to the type of room or apartment. Furnished and unfurnished apartments for single graduate students and for married graduate students and their families are located on the South Campus, approximately two miles from the Main Campus, and are serviced by a regular shuttle-bus.

Any student who wishes to live in Syracuse University housing should write to the Director, Office of Residential Life, Steele Hall, Syracuse University, Syracuse, New York 13210. Formal admission to graduate study is required before such requests are acted upon.

In addition, a wide variety of living arrangements in private homes and apartment complexes is available in the metropolitan Syracuse area.

OTHER COSTS

All graduate students are required to have health and accident insurance. Graduate fellows funded through the State University Research Foundation are required to take the health and accident insurance available through the Foundation.

The costs of textbooks and supplies may average $125 or more a year.

Financial Assistance

The College awards a substantial number of assistantships, fellowships and scholarships to qualified graduate students each year. The number of students receiving these awards varies from year to year, but usually more than half of all graduate students have received such support. In many cases it is not possible to provide a stipend at the start of the graduate study period, but such support is often provided after the student has demonstrated his competence.

Students may indicate their interest in a type of financial assistance on the last page of the graduate application form. Students on fellowships or assistantships must devote full-time to graduate study. Students seeking financial assistance should be sure their application and supporting documents reach the Office of Academic Programs before March 1, to ensure full consideration for an award for the fall semester.

GRADUATE ASSISTANTSHIPS

Assistantships are awarded to students of demonstrated scholarship and whose education and experience enables them to assist in laboratory instruction and research. The amounts of the assistantships range from $2600 to $4000 per year. In addition, tuition may be waived. Students on assistantships must carry 12 credit hours of course work, including research, per semester.

SPECIAL FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships and assistantships sponsored by industries, associations and foundations are available in several departments. The amount of stipends varies. Holders of these special fellowships and assistantships are required to confine the major part of their research activities to specified fields. Tuition is usually waived or provided by sponsors.

TUITION WAIVER SCHOLARSHIPS FOR INTERNATIONAL STUDENTS

Tuition waivers may be awarded to a limited number of international students judged to possess special academic capabilities and with demonstrated financial need, who are prepared to contribute to furthering international understanding and good will. Requests for such tuition waivers may be made on the last page of the graduate application forms.

TUITION ASSISTANCE PROGRAM

Qualified New York State residents are eligible for Tuition Assistance Program grants and State University Grants-in-Aid which vary with the net taxable family income of students, and the level of study, and provide substantial reductions in tuition. For details, contact the Coordinator of Financial Aid at the College.

LOANS

Graduate students may be eligible for various types of educational loans. The New York Higher Education Assistance Corporation offers

loans to residents which are interest free until after college, and then charges seven percent annual interest under current regulation. Repayment terms are arranged after graduation.

A graduate student who is a U.S. citizen may borrow up to $2,500 a year under the Student Loan Program of the National Defense Education Act of 1958. No interest will accrue until nine months after leaving college, and then it is at three percent. Part of the loan will be canceled if the student becomes a public school teacher or college teacher or enters military service. A ten-year repayment period is allowed.

OTHER FORMS OF SELF SUPPORT

Many graduate students support their studies through part-time employment at the College in laboratories and other College activities. Employment may also be sought outside the College on a part-time basis. Contact the Coordinator of Career Services for details and availability.

The College also participates in the Federal Work-Study Program which is designed to enable students to partially defray their educational expenses through part-time jobs during the academic year. Applications and further information are available from the College's Office of Financial Aid.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Graduate Degree Programs

COLLEGE-WIDE PROGRAMS

Environmental Science

The environmental problems facing the world today are a complex product of man's interaction with his environment, not a simple sequence of technological difficulties. They derive from a dynamic interaction of scientific, technological, design and managerial factors having economic, political and legal ramifications.

The graduate program in environmental science is an integrated, interdisciplinary scheme of course work and research unique to each student. It is designed to help the student develop a basic focus in one aspect of the environmental complex while developing a cognizance of other interrelated elements. The research components of the program encourages individual accomplishment and brings together students from diverse backgrounds in teams or task forces to research a particular environmental problem. Students bring to the task expertise in science, planning, management, design or engineering, and each learns to relate aspects of a common problem. In the process each develops insights through study of the social, legal, political and communications factors that are integral parts of the total problem. The student develops an enhanced understanding of environmental problems and valuable experience in seeking their solution.

The program is designed to be flexible in nature, and it enables the student to apply prior academic training in a discipline to the solution of an environmental problem, while developing additional training with broader implications. Other important inputs to this experimental program are the resources of Syracuse University in the course work areas of communications, policy, law, sociology and political science, all of which have become important in today's understanding of man's interaction with his environment.

The program in environmental science offers a wide range of study opportunities and draws upon and involves faculty, course work, facilities and philosophies of all the disciplinary degree programs which are described in the next few pages. The relevant pieces of these programs and the strength of them provide the necessary disciplinary support to make the concept of "interdisciplinary program" a viable entity.

Organic Materials Science

Organic Materials Science is that segment of the natural sciences that deals with the structure-property relationships in organic materials. For decades the College has been involved in various aspects of Organic Materials Science through programs in the sciences of paper, polymers and wood. An understanding of the behavior of materials in general has developed rapidly in recent years and it is now clear that many of the fundamental concepts of material properties are applicable to both natural and synthetic polymers. This thinking has led to the establishment of the new interdisciplinary program in Organic Materials Science. This program involves the Departments of Chemistry, Paper Science and Engineering, and Wood Products Engineering, the Empire State Research Institute, the Cellulose Research Institute, and the State University Polymer Research Center.

Organic Materials Science strives to instill in the student a broader perspective than is normally achieved in standard academic programs. This is accomplished by uniting the student's immediate research interests to larger goals involving several disciplines. In this manner a generalization of interest is acquired without sacrificing scientific rigor and depth of knowledge in more restrictive areas. Materials of current research activity include films, fibers, elastomers, composites, antithrombogenic materials, membranes, polyelectrolytes, polysalts, fiber assemblies, wood, paper, and wood-polymer systems, and involve studies in thermodynamics, statistical mechanics, chain conformation, crystallization, crystal morphology, X-ray, light scattering, polymerization, polymer reactions, wood and paper physics, elasticity, contractility, heat and mass transport, and paper properties. See also the sections of the participating departments and institutes.

Although graduate programs in Organic Materials Science are available at both the master and the doctoral level, it is expected that most students work for the doctoral degree. Programs consist of course work and research. Course work requirement is tailored to build upon the individual student's undergraduate background and experience. Entering students are expected to have a Bachelor's degree in chemistry, physics, engineering, polymer science, wood or paper science. The course work portion of the Organic Materials Science program will be directed toward background preparation in solid state and polymer science. Near the end of the student's course work program he will be exposed to the modern concepts of the structure-property relationships that are of importance in organic materials. Research topics will be selected to permit the student to explore in depth an aspect of organic materials in which he has a particular interest.

Students registering in the Organic Materials Science program satisfy all college-wide requirements for advanced degrees. Each student will be assigned a major professor and a faculty committee who will help him plan his course work program and who will serve as consultants on his research project. Courses will be selected from those offered, both at the College of Environmental Science and Forestry and the Colleges of

Engineering and Liberal Arts at Syracuse University. The research work will be carried out in College of Environmental Science and Forestry laboratories which are particularly well equipped for materials science studies.

Water Resources

The College is concerned broadly with biological and managerial relationships of forest resources, and the productive uses and benefits of forest products and services. The College has particular interests in the ecological and biological relationships having to do with the management and utilization of water resources; with problems of water quality, quantity, and availability as these are related to land use and development activities; and with the special problems of the forest industries which utilize water in manufacturing processes or produce by-products which affect water quality. The rehabilitation, protection and improvement of watersheds is an important corollary area of interest.

Graduate study programs in water resources may be arranged on an informal basis within several departments of the College to include the disciplines of economics, forest management, forest engineering, silviculture, landscape architecture, forest zoology, forest entomology, chemistry, and paper science and often involve support from several Colleges of Syracuse University.

The formal Interdisciplinary Program in Water Resources was organized in 1968 to supplement departmental programs by providing a sound basis for graduate academic programs designed to emphasize the multidisciplinary aspects of water resources. This effort recognized that water relationships are important in almost every aspect of human concern and merit attention as integrative and central elements rather than accessories. The Water Resources Program makes available to graduate students pertinent resources of the College and of Syracuse University, and where appropriate, those of other units of the State University.

The program is primarily for doctoral students. It is not structured in terms of required courses or content. Attention is given to the particular objectives of each student who enrolls in the program. Within the framework of the general graduate study requirements of the College, courses, programs and seminars are selected to attain the specific objectives and special interests sought by the student. The academic competence required is demanding. The programs arranged are broadly integrative rather than concentrated in a discipline. Critical review of the program proposed for each student is made by an assigned program committee to ensure that institutional standards are maintained and program objectives are met.

A major professor is assigned by the Program Leader to accept primary responsibility for the program of each student. Two additional faculty members in areas of expected academic or research emphasis are also selected. These three faculty members constitute the academic program committee for the student. The student is required to submit a formal report to the program committee consisting of a detailed work plan describing and defending his academic and research objectives and a schedule of courses and other elements of his contemplated study. This report is reviewed by the program committee, and is made a part of his permanent file. It is reviewed and updated at the beginning of each semester. The program committee will also serve as the thesis committee.

SCHOOL OF BIOLOGY, CHEMISTRY AND ECOLOGY

STUART W. TANENBAUM, *Dean* (Microbial Ecology and Metabolism)

BIOLOGY, CHEMISTRY, ECOLOGY

DEPARTMENTS and current degree programs	CHEMISTRY	BOTANY AND FOREST PATHOLOGY	ENTOMOLOGY	FOREST ZOOLOGY
CONCENTRATION AREAS	Environmental Chemistry Natural Products Natural and Synthetic Polymers Biochemistry	Anatomy and Morphogenesis Forest Pathology Wood Deterioration Mycology Physiology Taxonomy Genetics	Forest and Shade Tree Entomology Medical Entomology Environmental Entomology Biological Control Population Dynamics Behavior Taxonomy Toxicology Wood Deterioration	Bioenergetics Limnology Wildlife Management Animal Behavior Fishery Biology Soil Invertebrate Biology Animal Physiology

MULTIDISCIPLINARY CONCENTRATIONS

Ecology

Chemical Ecology

Environmental Biochemistry and Physiology

Pest Management

Botany and Forest Pathology

TEPPER, *Chairman* (Anatomy and Morphogenesis); AMES (Morphogenesis); GEIS (Ecology); GRIFFIN (Mycology and Fungus Physiology); KETCHLEDGE (Ecology and Bryology); MANION (Pathology); RAYNAL (Ecology and Taxonomy); SCHAEDLE (Physiology); SILVERBORG (Pathology); VALENTINE (Genetics); WANG (Mycology); WILCOX (Physiology of Growth and Development); ZABEL (Wood Deterioration)

The program in botany and pathology is designed to provide students with graduate level instruction in basic botanical and related natural and physical sciences. Research and thesis problems are generally designed to utilize forest organisms in the development of biological knowledge. Opportunities for graduate study within the program are offered in the fields of anatomy, morphogenesis, physiology-biochemistry, ecology, forest pathology, wood deterioration, mycology, genetics and taxonomy. Courses in climatology, meteorology, soils, ecology, bacteriology, botany, microbiology, genetics, mathematics, chemistry and statistics, all available in other departments at the College and at Syracuse University, provide additional support for the program.

Current areas of active research by departmental faculty are: *anatomy and morphogenesis*—factors that influence the development and form of root systems and regulate the development of root and shoot apices, cell differentiation in tissue culture; *physiology*—chemical regulation of organ growth, the nature and physiology of mycorrhizae, ion transport, mineral nutrition, biochemical aspects of cambial physiology, photosynthesis; *ecology*—dynamics of plant communities in the Adirondack Mountain Region and on the Allegheny Plateau, the influence of man on plant communities, the interaction of environmental factors during vegetational change, phytogeography and chemical ecology; *forest pathology*—disease of forest plantations, heart rots and cankers, tree rusts and physiogenic diseases; *wood deterioration*—the effects of stains and decays on wood use and their controls, the chemistry of wood decay, toxicity mechanisms and the bio-assay of toxicants; *mycology*—the taxonomy, sexuality, and morphology principally of wood-inhabiting fungi and microfungi; *fungus physiology*—the role of nucleic acids and intermediary metabolism in growth and morphogenesis; *genetics*—quantitative and population genetics, the heritability and natural variations in wood characteristics that are important in forest products and wood pulp; *taxonomy*—the identification, nomenclature and classification principally of fungi, bryophytes and vascular plants.

Illick Hall, the biological science building, provides faculty and students with modern facilities for botanical research. Special facilities include rooftop greenhouses, growth chambers, herbaria and special research laboratories for tissue culture, microchemistry, microtechnique, microscopy, radiochemistry, chromatography and computation. In addition, a cobalt-60 source, electron microscopy laboratory and a computer center are available at the College for student use. Extensive College forests, including most forest types of the Northeast, plantations and nurseries, offer exceptional opportunities for field study of forest plants and diseases.

Research in botany and forest pathology is supported by private industry, the U.S. Forest Service, the New York State Department of Environmental Conservation, the Research Foundation of the State of New York, a variety of Federal agencies and by the State of New York. In addition to direct project support, the grantees also provide for graduate research assistantships.

Entomology

SIMEONE, *Chairman* (Ecology and Wood-inhibiting Insects); ALLEN (Ecology and Population Dynamics); BREZNER (Physiology); CAMPBELL (Population Dynamics); JAMNBACK (Diptera Ecology and Control); KURCZEWSKI (Morphology, Taxonomy, Behavior); LANIER (Ecology, Cytotaxonomy); MILLER (Pest Information and Control); MORRIS (Medical Entomology); NAKATSUGAWA (Toxicology); NAPPI (Physiology and Pathology)

Opportunities for graduate study are available to students with interests in basic aspects of insect life and the roles insects play in relation to man and his environment. Research emphasis lies in biological and functional studies of selected insects, including host selection, insect-host-parasite relationships, insect physiology, biochemistry, toxicology and detoxification mechanisms; comparative systematics and behavior; communications; and histology and cytogenetics. Problems may concern forest, shade tree and wood-products insects, those relating to the well-being of vertebrates, including man; cultural and sanitary methods of prevention; biological, ecological (including pheromones), and chemical methods of control; and integrated pest management.

Interdisciplinary pursuits are encouraged in chemical ecology, genetics, forest pathology, vertebrate entomology, immunology and climatology involving other departments at the College, Syracuse University, and nearby Upstate Medical Center of State University of New York. Areas of specialization are enhanced by supporting courses in these other disciplines. Students interested in insect ecology, chemical ecology, physiology or taxonomy, for example, may pursue these subjects relative to plants and other animals by selecting courses in botany, silviculture, zoology, biochemistry and applied mathematics.

Students and faculty have a wide range of field and laboratory facilities available for research. The several forest properties represent varied forest environments, while Illick Hall provides modern controlled facilities and instrumentation. More than 18,000 square feet of indoor space is available, with access to an electron microscopy laboratory and scanning electron microscopes, environmental chambers, ultracentrifuges, nuclear magnetic resonance equipment, gas chromatograph, isotope laboratory, a cobalt source for irradiation, a soundproof room, glasshouses and an insectary complex affording subjection of insects to controlled as well as ambient weather conditions. The taxonomic museum houses nearly 100,000 insect species deposited by entomologists for more than half a century. A computer center provides services in all phases of entomological research.

Forest Zoology

ALEXANDER, *Chairman* (Vertebrate and Wetland Ecology); BEHREND (Wildlife Ecology and Management); BROCKE (Bioenergetics and Wildlife Ecology); CHAMBERS (Wildlife Ecology and Management); DINDAL (Invertebrate Ecology); GRAVES (Physiological Ecology); HARTENSTEIN (Invertebrate Physiology); MATTFELD (Bioenergetics and Wildlife Ecology); MITCHELL (Bioenergetics and Invertebrate Ecology); MULLER-SCHWARZE (Animal Behavior and Chemical Ecology); PAYNE (Wildlife Conservation); RINGLER (Fishery Biology); TIERSON (Wildlife Conservation); Van DRUFF (Vertebrate Zoology and Wildlife Ecology); WERNER (Limnology and Aquatic Ecology)

Graduate studies in zoology include both basic and applied research on animals of our natural ecosystems, including their associated soils and water. Programs are offered in vertebrate ecology, soil invertebrate ecology, physiology, population ecology, animal behavior, wildlife biology, aquatic ecology, wildlife management and fishery biology.

Many of the faculty and students are located in Illick Hall, the biological sciences building. Facilities include specialized laboratories for research in physiology, soil invertebrate ecology, animal behavior, aquatic biology and wildlife biology. An extensive collection of invertebrates is available, as well as the large Roosevelt Wildlife Collection. Various temperature-humidity chambers are available, including an environmental simulating chamber which programs and records light, temperature, humidity, altitude, wind and precipitation.

Graduate students may participate in an intensive research program in wildlife biology at the Archer and Anna Huntington Wildlife Forest Station, a 15,000-acre forest in the Central Adirondack Mountain region. Many forest types are present in varying stages of management. Three faculty members are year-round residents.

Field research may also be conducted at the College's Heiberg Memorial Forest and Experiment Station. Several other areas are located within a 35-mile radius of Syracuse, and frequently are used for research purposes. These include Onondaga County's Highland Forest; the Department of Environmental Conservation's wildlife management areas—Tioughnioga, Three Rivers, Howland Island and Cicero; the Montezuma National Wildlife Refuge; and privately-owned lands. A wide variety of ponds, streams and lakes in Central New York are regularly used by graduate students in aquatic ecology and fishery biology. Also, various forests, fields, aquatic areas and waste beds are used for invertebrate investigations.

These facilities and areas are supplemented by the services and facilities of the College's other departments, particularly the departments of botany and forest pathology, and entomology. The School of Environmental and Resource Management provides support in relating the managerial and silvicultural facets of forest resources to animal ecology and wildlife study programs. The College is adjacent to Syracuse University with its large department of biology, strong in physiology and developmental zoology. Available through this institution are programs in social sciences and engineering, including land use and environmental pollution.

The State University Upstate Medical Center also is nearby. Its facilities are available for graduate students whose research can benefit from the specialized library, equipment and faculty.

Examples of recent research include taxonomy and ecology of larval fish, trout management, limnology of lakes, succession in ponds, domestication, bird nesting behavior, deer behavior and bioenergetics, deer pheromones, wilderness wildlife, wild canid biology, ruffed grouse ecology, urban wildlife, waterfowl ecology, wetland ecology and planning, physiology of crustaceans, pesticides and soil fauna, soil invertebrate ecology and organic decomposition.

An interdisciplinary masters program in Fish and Wildlife Managerial Science is being developed.

Chemistry (Polymers, Natural Products, Biochemistry)

SMITH, *Chairman* (Physical and Polymer Chemistry); CALUWE (Organic Polymer Chemistry); LaLONDE (Organic and Natural Products Chemistry); SARKO (Physical and Polymer Chemistry); SCHUERCH (Wood and Polymer Chemistry); SILVERSTEIN (Ecological Chemistry); SMID (Physical and Polymer Chemistry); SZWARC (Physical and Polymer Chemistry); TANENBAUM (Microbial Chemistry); TIMELL (Wood Chemistry); WALTON (Biochemistry)

Recent years have seen profound advances in the fundamental knowledge of chemical areas which have special significance for forestry and the environment. The following research areas have received active attention by both faculty and graduate students in the programs: polymer chemistry and physics, wood chemistry, environmental chemistry, biochemistry, chemistry of natural products including ecological chemistry, and organic materials sciences. (See also Interdisciplinary Program in Organic Materials Science.)

Requirements for a master of science or doctor of philosophy degree in chemistry include a research project and thesis, along with an appropriate program of courses at the College and at Syracuse University.

Specific projects may vary from year to year, since they reflect the current interests of the faculty. Current research projects with *physicochemical* emphasis are: the chemistry, physics, solid state and solution properties of natural and synthetic polymers, including studies in thermodynamics, statistical mechanics, crystallization, morphology, elasticity, conformation of macromolecules, optical properties, polymer catalysis, mechanism of polymerizations, polyelectrolytes, ion binding to macromolecules and ion pairing; chemistry of free radicals, radical ions and charge transfer processes; structure and properties of ionic solutions in nonaqueous media; crystal structure and morphology of cell wall constituents; heavy metal speciation. Current *organic* chemistry programs deal with synthesis of special polymers such as high temperature aromatic block, stereoregular vinyl polymers, and polysaccharides, various aspects of natural products chemistry, but especially alkaloids and terpenes, isolation and characterization of insect and mammalian attractants. An active program on the structure and topochemistry of the *polymeric* wood components, hemicelluloses, lignins and celluloses is underway. In *biochemistry*, department members are studying mechanisms of action of plant growth hormones, biochemical regulation of seed germination, plant enzymology and ultrastructural plant cytology.

Graduate research laboratories in the Hugh P. Baker Laboratory are well equipped for polymer studies, chemical and biochemical research. Instrumentation includes analytical and preparative ultracentrifuges, Warburg respirometer, recording infrared and ultraviolet spectrophotometers, mass spectrometer, differential refractometer, electron spin resonance spectrometer, nuclear magnetic resonance spectrometer, automatic membrane osmometers, solid and solution state light scattering photometers, recording polarimeter and optical dispersion spectrometer, several ultramicrotomes, electron microscopes, X-ray diffraction, instrumentation chromatography and cold laboratories, and radiochemical laboratories with counters for solids, liquids and gases.

SCHOOL OF ENVIRONMENTAL AND RESOURCE ENGINEERING

ROBERT V. JELINEK, *Dean* (Computer Applications, Process Engineering, Corrosion)

Graduate studies and related research activities in the School of Environmental and Resource Engineering are concerned with optimum development and utilization of natural resources, including structure, properties and manufacture of solid and composite wood products, paper and related fibrous materials. Program elements include various aspects of site evaluation and enhancement, unit and system design, production and processing and qualitative and quantitative measurement and computation. Environmental conservation and pollution abatement are stressed.

Individually designed programs of study leading to the M.S. or Ph.D. degree are available for students with baccalaureate degrees in engineering, forestry, natural sciences, chemistry, physics or mathematics. These programs draw upon the resources of three departments with complementary interests, namely *Forest Engineering, Paper Science and Engineering* and *Wood Products Engineering*. A student may elect to specialize in one of these areas or to pursue a program of study combining their offerings to suit his or her background and educational goals. Courses offered by other departments of the College and Syracuse University are frequently included where appropriate.

Forest Engineering

TULLY, *Chairman* (Structures, Water Resources, Soil Mechanics); BENDER (Geodesy, Photogrammetry, Land Data Systems); BROCK (Analytical and Interpretive Photogrammetry, Remote Sensing); LEE (Systems Engineering, Computers, Soil Mechanics); LILLESAND (Remote Sensing, Environmental Monitoring and Transportation); PALMER (Harvesting, Systems Engineering)

Graduate study in forest engineering is primarily concerned with the application of engineering principles to the conservation, restoration and holistic development of the natural environment and its resources. The objective is to provide graduates with a sufficient understanding of the methodologies of scientific research, and of the principles of engineering measurement, analysis or design to work with competence in resource-related research, engineering design and management.

Programs of emphasis on environmental engineering measurements can be designed in remote sensing, photo interpretation, geodetic engineering, analytical photogrammetry and resource information systems. Programs emphasizing engineering analysis and design are available in water resource, transportation, harvesting and site engineering systems.

Internal support for forest engineering includes modern laboratory and instrumentation facilities in the Engineering Schools at both the College and Syracuse University. Exceptional departmental support exists for programs which involve environmental engineering measurements. The extensively equipped photogrammetric and remote sensing laboratories and over ten kilohectares of forest properties owned by the College provide a uniquely controlled setting on which research may be conducted.

External support comes from several industrial, commercial and governmental sources. Over the past two decades, close cooperation has developed special study and research opportunities with these sources.

Paper Science and Engineering

LEOPOLD, *Chairman* (Organic Chemistry and Mechanical Properties of Fibers and Paper); BAMBACHT (Pulping, Papermaking, Water Quality); DENCE (Organic Chemistry and Lignin Reactions); GORBATSEVICH (Pulping, Bleaching, Paper Technology and Paper Properties); LUNER (Mechanical and Surface Properties of Fibers, Films and Paper); MARK (Fiber Physics); MARTON (Paper Properties, Microscopy and Pulping); STENUF (Chemical Engineering, Instrumentation, Thermodynamics, Process Control, Metallurgy and Corrosion)

Outstanding for its vigorous growth and diversity of products, the pulp and paper industry is the fifth largest in the nation and exceptionally strong worldwide. The need for professional men and women with advanced education in science, engineering and technology is increasing even more rapidly than the industry itself. The College pioneered in providing graduate study in this area in 1920 with the organization of the paper science and engineering department, which has maintained a singularly high position in professional education for the continuing development of the pulp, paper and allied industries. Its graduates, who are in constant demand, occupy positions of leadership throughout the world.

Graduate studies reflect the strong trend toward diversification in the industry and offer opportunities for obtaining master of science and doctor of philosophy degrees in a variety of subjects related to the manufacture of pulp and paper. Advanced courses are offered in such diverse areas as chemistry, paper physics and fiber morphology, as well as specific areas of pulping and paper properties.

Walters Hall, opened in 1969, is devoted exclusively to education and research in this field. Containing a large number of special purpose laboratories and highly sophisticated equipment, it houses one of the outstanding research facilities in the world, the Empire State Paper Research Institute (ESPRI).

Research activities aim to generate new information regarding the fundamentals, the science, the engineering and the technology of the papermaking process, utilizing advanced techniques such as electron microscopy, specialized spectrophotometry, nuclear magnetic and electron spin resonance and nuclear tracer methods. Also included is a modern chemical engineering laboratory, designed for studies in all phases of unit operations and processes, process control, thermodynamics and analog simulation.

The department maintains an experimental pulp and paper mill equipped with machinery and instrumentation for studies of pulping, pulp purification, reuse of secondary fibers, refining, paper additives and papermaking. This facility includes a paper machine, a 400 horsepower double-disk refiner, a two-pocket grinder for mechanical pulping and auxiliary equipment. Recent work has been directed to fundamental investigations of pulping, bleaching, additives, recovery of secondary fibers, the papermaking process, reactions of wood components during mechanical and chemical treatments, evaporation, fluid dynamics, heat transfer, the structure of wood and wood fibers and chemical and fiber recovery.

The department enjoys excellent external support in the form of graduate fellowships and other grants from ESPRI and other industry sources, as well as a number of government granting agencies.

Wood Products Engineering

DAVIDSON, *Chairman* (Organic Materials Science); CÔTÉ (Cellular Ultrastructure, Light and Electron Microscopy); DeZEEUW (Wood Anatomy, Structure-Property Relations); KYANKA (Applied Mechanics, Structures); MEYER (Wood-Polymer Systems, Radio-Isotope Techniques); MOORE (Bonded Materials Technology); PENTONEY (Mechanical Behavior, Fracture Mechanics); SIAU (Protective Treatments, Transport Processes); SKAAR (Wood Physics); G. SMITH (Materials Marketing); L. SMITH (Polymeric Adhesives and Coatings); WHITT (Industrial Engineering)

While wood is one of the oldest structural materials known to man, its economic importance today is reflected in the fact that the annual tonnage of wood produced in the United States far exceeds that of any of the other major structural materials. This fact becomes even more important in this age of environmental and ecological concern because wood is the only major structural material that comes from a renewable natural resource, and demand is growing for more efficient utilization of available material. Improved efficiency must be based on solid scientific and engineering information. Thus research projects aimed at providing such information form the basis of graduate study in wood products engineering. The major areas of specialization are: wood science, wood products engineering (with emphasis on either structures or production systems) and product distribution systems.

Basic degree requirements for either a master of science or a doctor of philosophy degree include appropriate course work, which prepares the student to undertake a research project culminating in the writing of a thesis.

Recent research projects in wood ultrastructure have dealt with the interaction of coatings and glues with the wood substrate, cell wall development, the effectiveness of wood preservatives and the identification of natural inclusions in wood. The field of wood physics has had active projects in the permeability of wood, the mechanisms of fluid transport and the mechanisms of electric charge transport. Current projects are underway in the mechanical behavior of fiber networks, fracture mechanics of wood and the behavior of new structural designs which represent interests in the field of mechanics. In addition, there is a newly emerging field dealing with the properties of wood-based composite materials.

Laboratory facilities include a modern mechanics laboratory which has a range of mechanical testing machines, a well-equipped physics laboratory with various electronic instrumentation, and complete wood processing facilities including a sawmill and veneer mill. An extensive foreign wood collection provides the basis for a new Tropical Timber Information Center.

In addition, the College has available a complete microscopy laboratory, containing both scanning and transmission electron microscopes and a wide variety of light microscopes and related equipment. Extensive equipment for chemical analysis and nuclear chemical techniques serve the College's research program.

SCHOOL OF ENVIRONMENTAL AND RESOURCE MANAGEMENT

CHARLES C. LARSON, *Dean* (Resource Policy and Administration, International Forestry)

Department of Managerial Science and Policy

DALL, *Chairman* (Environmental Policy and Law); ARMSTRONG (Industrial Economics, Resource and Market Analysis); BENNETT (Economic Theory, Economic Thought in Forestry); CANHAM (Regional Economics and Planning); CHRISTIANSEN (Forest Production Economics, Economic Systems Analysis); CUNIA (Operations Research, Statistics, Mensuration); GRATZER (Forest Recreation, Resource Management); GRAVES (Resource Policy, Planning, Management); HANSELMAN (Educational Communications); HENNIGAN (Resource Policy, Management); KOTEN (Management, Systems Analysis); MORRISON (Sociology of Outdoor Recreation); MUNIAK (Environmental and Resource Administration and Politics, Policy Planning); PETRICEKS (Macroeconomics, International Forestry Economics); STITELER (Biometry, Experimental Design, Computer Analysis)

Department of Silviculture and Forest Influences

JOHNSON, *Chairman* (Silviculture); BERGLUND (Silvics); BLACK (Watershed Management); CRAUL (Forest Soil Science); ESCHNER (Forest Influences); HERRINGTON (Meteorology); LEA (Silviculture); LEAF (Forest Soil Science); RICHARDS (Silviculture, Environmental Science); WESTFALL (Physiology-genetics, Tree Improvement)

Adjunct Faculty

CHRISTENSEN (Forestry Economics and Policy); ECHELBERGER (Forest Recreation Research); HEISLER (Meteorology); MINCKLER (Hardwood Silviculture); WAGAR (Forest Recreation Research)

The School of Environmental and Resource Management is charged with responsibility for providing quality professional education in natural resource management, with particular emphasis on the resources of forest and associated open lands and their environmental influences, and with the conduct of strong programs of related research, public service and consulting. In accord with this broad mission, the School provides formal instruction at both the undergraduate and graduate levels and leading to the Bachelor of Science, Master of Science and Doctor of Philosophy degrees. Its undergraduate curriculum in environmental and resource management meets the accreditation requirements of the forestry profession as set forth by the Society of American Foresters. The basic objective of this program is to prepare students for the critical role of evaluating alternate goals in forest and associated land use, of recommending optimum approaches to the realization of these goals, and of working effectively with landowners, resource users and the general public in the formulation and implementation of resource policies and programs in the best interests of all concerned.

Graduate education in the School of Environmental and Resource Management builds upon the basic foundation of professional knowledge acquired by students in its undergraduate curriculum or in similar or closely allied programs of study. Instruction at this level is designed to prepare students for careers in resource administration, professional education and research, and a variety of other specialized positions in public and private employment bearing directly or indirectly on natural resources and environmental management. As shown in the figure below, the School offers advanced study opportunities under two broad degree programs: Resource Management and Policy and Silviculture. In addition, its faculty contribute significantly to several College-wide graduate programs and joint areas of advanced study, including fish and wildlife managerial science, water resources, environmental planning, environmental science, and soils science.

Several areas of specialization are available within the two degree programs, as shown, But opportunity is also provided for students, in consultation with faculty advisors, to arrange areas of study specific to their interests and needs which integrate elements of two or more areas

SCHOOL OF ENVIRONMENTAL
and
RESOURCE MANAGEMENT

GRADUATE PROGRAMS
and
Areas of Specialization

RESOURCE MANAGEMENT AND POLICY

Forest Management
Recreation Management
Policy and Administration
Forestry Economics
Quantitative Methods
Land Use Planning
Environmental Communications

SILVICULTURE

Silvics
Silviculture
Forest Soil Science
Tree Improvement
Forest Influences

World Forestry

of specialization, as in the case of world forestry. Whatever the program, the basic purpose is to help the student acquire the tools and facility for disciplined, logical, critical, constructive and creative thinking, and for clear expression in the selected field.

Prospective students who desire more information than is presented for each of the graduate programs and specialties described below should contact the Dean, School of Environmental and Resource Management.

Resource Management and Policy

Today's successful resource manager is one who can anticipate and prevent environmental troubles as well as attempt to remedy them; who is equipped not only to make current institutions function effectively but also to create new ones better fitted to changing social needs; and who can bring the strengths of many disciplines to bear on vexing environmental problems.

The Resource Management and Policy Program has been designed to meet the need for capable managers by requiring broad acquaintance with several fields, by developing strong integrative facility and long planning horizons, and by encouraging team attack on complex problems.

Specialized areas in *forest management, recreation management, policy and administration, forest economics, quantitative methods* and *land use planning*, are described below. Depth in each area is balanced by required understanding of both the physical-biological and the social systems which merge to form the context for wise resource development. Integration of fields is gained through study of current issues and application of managerial tools to real-world conditions. In all specialties, focus is on the goals of management, on advanced techniques for meeting them and on current and prospective issues and how to attack them. The rich resources of the College's other Schools and of Syracuse University are drawn upon freely in support of program efforts.

Forest Management

The forest management area focuses on the planning and implementation processes necessary to achieve integrated use of forests and related resources. The objective is to develop expertise sufficient for capable, professional resource management to satisfy a wide range of societal needs.

Broad knowledge of the operation of both biological and social systems is combined with skill in the use of managerial tools. Concepts in decision theory, and information and organization theory, particularly, are applied to representative cases at varying levels of complexity. Syracuse University's School of Management and Maxwell Graduate School of Citizenship and Public Affairs offer a broad array of support courses. Students prepare themselves for any of a wide range of positions in research, program analysis, teaching, administration, budgeting and other phases of forest resource management with federal and state agencies and private firms.

Recreation Management

Graduate study in this area equips students with broad understanding of the nature and purposes of outdoor recreation and how it relates to natural resources, and builds the skills necessary for capable recreation management.

Individual programs combine study in resources management with relevant studies in the social sciences and development of analytical and political capabilities needed to implement plans and programs. The U. S. Forest Service Research Unit, situated on campus, provides strong support for research and independent study. Other schools of the College and of Syracuse University, treating such areas as planning, engineering, design and education, provide a wide range of supporting courses and facilities.

Policy and Administration

Graduate study in the area of policy and administration prepares students for the broad range of responsibilities comprising the field of program administration in a public agency or a business at the executive, planning, budgeting, programming or operating levels. Advanced courses, special problems and seminars structured around man-resources relationships, resources policy issues, administrative management, and environmental law are offered.

Students are encouraged to round out their academic programs through the offerings of other units of the College as well as the Syracuse University Maxwell Graduate School of Citizenship and Public Affairs and the School of Management.

The wide-ranging possibilities of course selection and the differing points of view that are available allow the student to tailor a program to meet specific career objectives. This breadth and diversity also offers the student an opportunity to develop talents for top executive leadership in various aspects of a field that is critical to the future of resource management.

Forest Economics

In this area, study at the master's level is designed to meet the needs of the graduate in forestry or forest products. It also serves the graduate in liberal arts, engineering or business whose interests point toward the economics of forest resource management. The aim is primarily to broaden the student's understanding of the content of forestry economics.

The Ph.D. program is for those who wish to make a career as professional forestry economists in research institutions, in the academic world, or in business or government. The goals are depth of understanding and familiarity with economic tools contributory to making competent decisions in resource economics, management and policy. Requirements are generally the same as those observed in economics departments of leading universities, except that the student completes specified work in the economics of forestry.

Individual programs may include supporting courses in general economics, mathematics and statistics, operations research, business, international affairs and other social sciences and related fields. The broad array of course offerings and substantial library resources, computer facilities and other resources of Syracuse University supplement those of the College.

Quantitative Methods

Study in the area of quantitative methods is designed to develop professionals skilled in mathematical and statistical problem solution and equipped to act as biometricians, mensurationists or in similar posts, with state and federal agencies and with private firms.

The program is designed primarily for students who have done their undergraduate work in areas such as biological sciences, forestry, wildlife or agriculture. Others, who lack background courses, may take this material concurrently. Students may concentrate in statistics, operations research, biometry, or forest mensuration. Syracuse University's IBM 370 computer, programming banks and a wide range of courses in mathematics, statistics and quantitative methods give strong support to the program.

Land Use Planning

Graduate study in land use planning aims to show how development and utilization of the land resource affects and is affected by natural and social systems. It provides basic understanding of the tools and processes of regional planning and addresses land use policy issues. Student programs are flexible and draw heavily from course offerings in resource economics, resource policy and administration, open space planning, and applied ecology. In addition, the rich course offerings of other Schools and Syracuse University in such areas as remote sensing, geography and metropolitan studies are available. Some undergraduate work in the natural and social sciences is required.

Employers normally include county, regional and state planning commissions; federal agencies such as the Forest Service; and private consulting firms. Consultation from these sources is encouraged in graduate theses and research, and in the conduct of seminars.

Graduates find employment in resource management agencies administering recreation areas; in national, state and local parks and recreation departments; in educational institutions and in private organizations involved in recreation.

Environmental Communications

This area of study prepares specialists to interpret effectively, for a wide range of publics, biological, ecological and socioeconomic events relating to natural resource management and use and the protection and enhancement of environmental quality. Understanding of the operation of natural resource systems and of social and managerial systems is combined with expertise in education and in the tools of communication, including print, nonprint and other instructional technologies, to develop skill in analyzing and interpreting resource and environmental affairs.

Individual study programs draw heavily upon instructional resources not only within the School of Environmental and Resource Management, but also in other schools of the College and Syracuse University, especially the latter's Newhouse School of Public Communications. Independent studies, special projects and internships are often a major component of study programs.

The breadth of study options allows students to orient their career goals within a wide range of employment possibilities. Graduates find employment with resource management agencies, industrial firms and associations, community environmental education centers, private environmental organizations, conservation associations, professional societies, post-secondary educational institutions, and the mass media.

Those who aspire to study in this program area must possess or be prepared to acquire the necessary background for graduate candidacy in resource management and policy. Students who do not have such background or whose career objectives are not commensurate with resource management will be encouraged to pursue their environmental communication interests through the graduate program in Advanced Environmental Science described elsewhere in this catalog.

Silviculture

Concern for the forest ecosystem provides a major focus for graduate study in the Silviculture Program, with this ecosystem viewed in its role as a producer of goods and services and as a modifier of the physical environment in which man lives. It is in this context that translation of these concerns to broader questions of environmental quality is emphasized.

Silviculture in its functional sense is the bridge between fundamental biological and physical relationships and the applications of these relationships in the forest environment. Thus, graduate study in the many aspects of silviculture can cover a broad spectrum of disciplines, and can be as basic or as applied as the objectives of the student call for. Individual study programs are coordinated with various areas of specialization both within the Department of Silviculture and Forest Influences and with other departments of the College and of State University of New York, and, as well, with Syracuse University. A major strength is the close association of scientists representing a wide range of specialties, and both formal and informal cooperative arrangements between these scientists and their counterparts in federal and state agencies and in industry.

Physical facilities that are routinely used in graduate study within the Silviculture Program include well-equipped laboratories, specialized equipment, and greenhouse facilities; and extensive College forests of nearly 25,000 acres on which are located natural and planted stands, seed orchards, a forest tree nursery, and two large micro-climate tower complexes with associated automated data acquisition systems and instrumentation. Major field installations include long-term northern hardwood stand improvement studies and the oldest continuous forest fertilization studies in the United States.

Included within the Silviculture Program are five fields of specialization that, singly or in combination, provide the graduate student with a wide array of course work, research activities, and faculty guidance all aimed at enhancing his understanding of the forest ecosystem. These specializations are silvics, silviculture, forest soil science, tree improvement, and forest influences.

Silvics

Silvics is often defined as that branch of forestry which provides the scientific base for the cultural treatment of forest vegetation by (1) defining interrelationships within forest ecosystems and (2) cataloguing general intraspecific characteristics of tree species. In a sense, silvics is the ecology of managed forest ecosystems, although unmanaged and natural forests are often studied intensively because they provide the benchmark conditions from which the silviculturalist begins.

The specialist in silvics must maintain channels of communication with his colleagues in the basic disciplines, including those in soil physics, soil chemistry, micro-meteorology and climatology, genetics and tree breeding, plant physiology, wildlife biology, entomology, and pathology.

In addition, certain tools, including a comprehensive knowledge of probability and statistics, the ability to use modern computers effectively, and a familiarity with measurement and sampling theory, are required by specialists in most applied sciences including silvics.

The specialist in silvics is essentially at one focal point of much of what has been called fundamental forest research. His most useful function and worthwhile contribution to the field of forestry may very well depend on his ability to synthesize relevant material and, through experimentation, provide the silviculturist with information and possibly techniques for use in the cultural treatment of forest vegetation.

Silviculture

Classical silviculture can be defined as the theory and practice of the manipulation of forest ecosystems, including the control of vegetation establishment, composition, growth, and quality. The nature of cultural treatments, the theories upon which they are based, and the biological, physical, and social constraints to their implementation are stressed in this area of specialization. Elements of forest vegetation are intensively examined from the dual standpoints of fulfilling management goals for goods and services while maintaining or enhancing biotic productivity for the future.

Management goals are considered to include all the many and varied goods and services that the basic forest resource is capable of supplying. Forest productivity is of basic concern; the student specializing in this area progresses through formal course work and research toward an understanding of the effects of various treatments on the continuous, balanced, and adequate supplies of wood, water, wildlife, recreation opportunities, and amenity values. While major emphasis relates to treatment of tree stands for their continued production of wood products, increasing attention is directed to the cultural practices important for primarily non-commodity forest values.

The Silviculture graduate specialization is aimed at preparing foresters to understand and evaluate forest ecosystems in whatever depth may be required, and to prescribe treatments or further experimentation to attain management objectives or increase knowledge toward this end.

Forest Soil Science

Graduate studies in this area of specialization may be directed toward aspects of soil science related to the quantity and/or quality of goods and services in the management of resources of non-agricultural lands, and the impact of management practices on environmental quality. These include soil moisture, soil temperature, and nutrient element status interrelationships in the evaluation of soil productivity; evaluation of ecosystems to quantify nutrient element balances and cycling; amelioration of soils for increased productivity; and impact of various land-use practices on soil productivity.

Modern well-equipped laboratories are available for graduate student use in plant, soil, and water chemical analyses; soil water-holding capacity and compaction; infiltration and runoff; and other chemical and physical property investigations. The extensive College properties noted previously permit forest soil research to be conducted under a wide variety of environments and ecological conditions.

Programs are coordinated with other areas of specialization through cooperation among Department personnel, with other departments of the College, Syracuse University, and the U. S. Forest Service.

Tree Improvement

Graduate study in tree improvement is designed to educate highly competent people at the master's and doctoral levels and to derive new concepts in applied forest genetics. A broad spectrum of basic and advanced courses are available at the College and at Syracuse University.

In his thesis research, the student has the flexibility and opportunity to pursue varied research interests as well as contribute to long-term basic problems. Current active and potential research problems include the genetics of wood quality, ozone resistance in eastern white pine, the genetics of pest-host relationships, the biology of monoterpenes and resin acids in forest trees, and genecological variation in forest trees. Graduates are qualified to fill a variety of positions in research, or tree improvement operations.

Forest Influences

Forest Influences as an area of graduate study includes all the effects resulting from the presence of forest trees and associated vegetation on climate, the hydrologic cycle, erosion, floods, and soil productivity. Health considerations and human comfort have often been included in older definitions of forest influences, and are assuming greater importance today with our growing concern for the environment.

Included among the principal studies in this area are energy exchange between forest and atmosphere; moderation of urban environments by vegetation; soil and slope stability; and watershed hydrology, including snow.

Graduates fill a variety of positions in research, teaching, and public and private management, as watershed management specialists, hydrologists, environmental officers, meteorologists, and ecologists.

World Forestry

Graduate education in world forestry as an area of emphasis is available to students under both the Resource Management and Policy and Silviculture curricula and is designed to assist individuals who are intent upon pursuing internationally-oriented careers in forestry and related fields.

Instruction is aimed at supplementing and enriching the student's technical forestry knowledge and providing the broad background deemed necessary for effective service as forestry advisor, teacher, or research specialist with national and international agencies, private business and industrial firms, philanthropic foundations and voluntary service organizations whose activities include the development and use of forest resources in other lands.

At the master's level, program emphasis is on the attainment of general competence in research methods, foreign languages, cultural anthropology, world geography, and international affairs, plus a broad understanding of the world forestry situation. At the doctoral level, program concentration is on a specialized discipline area such as forestry economics, forest policy and administration, forest management or silviculture. Orientation to the world forestry field is achieved in part through the selection of formal course work, and in part through providing an opportunity for the student to conduct his thesis research in residence abroad.

A wide variety of course offerings are available to support the nonforestry elements of this area of study through Syracuse University. Opportunity for field training and research in tropical forestry and related fields is available to qualified candidates, especially at the doctoral level, under cooperative agreements maintained by the College with the Institute of Tropical Forestry in Puerto Rico and the University of the Andes, Merida, Venezuela.

SCHOOL OF LANDSCAPE ARCHITECTURE

BRADFORD G. SEARS, *Dean* (Natural Area Studies)

CURRY (Urban Analysis and Design); EARLE (Art and Design, History of Environmental Development); FELLEMAN (Site Engineering, Resource Policy Administration); FREEMAN (Plant Materials, Site Design); HARPER (Regional Environmental Planning); LEWIS (Community Planning, Systems Dynamics, Gaming Simulation); NIEMAN (Regional Planning and Environmental Impact); PAULO (Design, Environmental Law); POLLAK (Social Policy Planning and Analysis, Social Geography); REIMANN (Methods and Philosophy of Design); TRYON (Design Methods, Site Design)

Landscape Architecture

There has always been a need and a desire for man to adjust to his physical environment, or to modify it in order to meet his requirements for shelter, sustenance and communication. Society has reached the point in the latter half of the 20th century where economic and technological sophistication enables man to completely control the physical environment. It is within the balance between man and nature, and the manipulation of land as it relates to man's use, that the role of the landscape architect lies. The professional landscape architect is concerned with the quality of the condition and form of the physical/cultural landscape. Because of this concern, the landscape architect may work at any scale, from small site design projects with their related designed amenities, to the orchestration of regional, national or international projects which attempt to develop policy for qualitative use of land.

Landscape architecture is about land and people. The very dynamics of this relationship has lead to a profession which is always changing to keep abreast of man's needs.

The MLA degree program offers the opportunity to study advanced concepts and methods in landscape architecture. It is normally completed in two years. The curriculum has three aspects: a sequence of required core courses; a series of elected courses; and a terminal study.

Studio workshop courses, seminars and courses in methods and topics for environmental research form the required core sequence. The emphasis in these courses is on identification and definition of environmental problems, development of strategies for their solution and utilization of sophisticated methods and techniques in their resolution.

Complementary to the required courses, the degree candidate takes a series of elective courses normally chosen from the School, the College of Environmental Science and Forestry or Syracuse University. Each student orients the choice of elected courses according to personal educational objectives. The student may wish, for example, to specialize in one or generalize in the many disciplines related to the needs of the professional landscape architect. Upon the approval of the faculty, a student also has the opportunity to take a part of the elected course work in self-described independent study.

Each MLA degree candidate completes the degree requirements by preparing a well-documented terminal study and satisfactorily defending the work in an oral examination. The terminal study is normally completed during the fourth semester of residence.

Research at the School, both sponsored and independent, has two major thrusts. The first is applied research. Here emphasis is to develop greater sophistication in contemporary methods and techniques used to solve real environmental problems. The second is original research, where the emphasis is to develop new data, criteria or methods which can be used in solution strategies for environmental problems.

The College library and the several libraries on the Syracuse University campus offer in-depth reference material to support study programs. Facilities at the School are extensive. They include adequate studio and office space as well as reproduction, model making, photographic and audio-visual equipment. The College maintains a computer center which is used primarily for instruction and is available for individual use by graduate students. The College also has a fully equipped video tape recording (VTR) studio and photogrammetric labs.

The School is unique in its location within the College of Environmental Science and Forestry. This situation provides the MLA candidate with the opportunity to draw upon information and knowledge in ecology, natural sciences, resource management, forestry and many other related environmental concerns. In addition, the relationship with Syracuse University provides the School with a wide-ranging human and physical resource base.

The Syracuse area has the largest concentration of landscape architectural firms in the State, outside of New York City. With a metropolitan population of nearly 500,000, the city has many opportunities for urban-oriented study. Also, the city's central location in upstate New York provides easy access to a rich variety of public lands and recreation areas which are planned and administered by a diverse range of governmental agencies and private owners.

Any student with a bachelor's degree, or the equivalent from a college or university of recognized standing, is welcome to apply for admission to the MLA degree program. Along with the general application requirements of the College, each applicant is encouraged to submit any examples of work, such as academic reports, terminal projects and portfolios of creative endeavors or design work.

Course Offerings

Graduate students at the College of Environmental Science and Forestry have not only the academic and research resources of their own institution, but also the resources of nearby Syracuse University and State University Upstate Medical Center.

In graduate programs at the College, Syracuse University courses are used extensively in the fields of mathematics, physics, chemistry, biology, engineering, economics, business and citizenship. The State University Upstate Medical Center has courses available for graduate programs in the areas of anatomy, biochemistry, cytology, microbiology, and physiology.

DESCRIPTION OF COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY COURSES

The courses offered by the College are grouped by general subject areas, and the number of credit hours appears after the course title. A credit hour means one recitation (or lecture) hour per week. Three laboratory hours are equivalent to one lecture hour.

Course Numbering System (Effective June, 1973)

Code Levels:

500—599 Graduate Courses designed expressly for graduate students, in areas supporting their specialization or interdisciplinary program, or for fifth year professional students with baccalaureate degrees (e.g. BLA students with B.S. in Environmental Studies), and available for undergraduate credit by selected upper division undergraduate students with superior academic records.

600—699 Graduate courses designed for beginning graduate students. Undergraduates are permitted admission only by petition with a well-documented justification approved by the undergraduate advisor and curriculum director and the instructor of the course.

700—899 Advanced graduate courses designed primarily for second and third year graduates and beyond, but available to all graduates.

900—999 Special graduate courses available only to doctoral students.

APPLIED MATHEMATICS (APM)

500. Introduction to Computer Programming for Graduate Students (3)

This basic course in computer use offered by the College is intended to provide the student with the skill and understanding needed to utilize digital computer languages for problem solving. The course includes a rather detailed study of Fortran IV, plus some discussion of an Assembly language and moderate study of Cobol and APL. To provide completeness, some attention is also afforded to techniques of representing information, managing files, error control and to operating systems and job control. This course or a demonstrated equivalent is a prerequisite to individual student use of the College computer facilities. Fall and Spring.

605. Theory of Probability Distributions (1-3)

Three hours of weekly sessions over 5-14 weeks. Statistical problems and mathematical models; random experiments, random variables, probability, frequency and distribution functions of discrete, continuous and mixed random variables; functions of random variables and their probability distributions; mathematical expectation and its applications; discussion of the main theoretical distributions such as binomial, Poisson, negative binomial, normal, Gamman, Beta, exponential and others; applications of this framework to the model construction problem in the statistical, operations research and forest mensuration areas. Fall or Spring. Mr. Cunia.

Prerequisites: Two semesters of differential and integral calculus and an introductory course in statistics, or permission of the instructor. The course can be taken in conjunction with APM 651—Operations Research I (for 1 credit hour) or independent of it for 1 to 3 credit hours.

610. Statistical Analysis (3)

Two hours of lecture, three hours of lab. A treatment of statistical inference, including paired design, group design, linear regression and correlation, one way analysis of variance and some applications of chi-square. Calculation of statistics, tests of hypotheses and proper interpretation of calculated statistics. Fall. Staff.

620. Analysis of Variance (4)

Three hours of lecture and recitation, three hours of lab. Multiway classifications in the analysis of variance, with emphasis on the development of models, including randomized blocks, latin squares, split plots, and factorial designs with fixed effects, random effects, and mixed effects; multiple and partial regression and correlation (including curvilinear), using matrix methods; analysis of covariance, higher order contingency tables, distribution free methods, and sequential testing. Spring.

Prerequisite: Graduate standing and an introductory course in statistics covering material through the one-way analysis of variance.

625. Introduction to Sampling Techniques (3)

Two hours of lecture, three hours of lab. Introduction to the scientific basis of sampling: selecting an appropriate sampling unit; choosing an efficient design; calculating sampling error; determining a sample size to meet stated objectives. Spring. Staff.

Prerequisite: APM 491 or equivalent.

630. Topics in Advanced Mensuration (3)

Two 1½ hours of lecture per week. Topics to meet students' interests are selected from the following areas: systematic, stratified and cluster sampling; ratio and regression estimates; photo interpretation and double sampling; sampling with unequal probabilities and 3P sampling; Continuous Forest Inventory (CFI) and Sampling with Partial Replacement (SPR). Introduction to Matrix Algebra and its application to Multiple Linear Regression, Weighted Least Squares Method, Volume Table Construction, and Analysis of Covariance by dummy variables. Applications of mathematical programming and simulation techniques to management problems involving optimization of cost functions. Fall. Mr. Cunia.

Prerequisites: ERM 436 and APM 491 or equivalent.

635. Multivariate Statistical Methods **(3)**
Estimation and inference for the multivariate normal distribution. Multivariate analysis of variances, factor analysis, principle components analysis, canonical correlation, discriminate analysis, cluster analysis. Spring. Mr. Stiteler.
Prerequisite: One semester of statistics.

651. Operations Research I **(3)**
Two 1½ hours of lecture. Stochastic or models applicable to managerial process or systems analysis. Elements of probability theory, theory of games and decision theory, queuing model, simulation techniques with applications to queuing and inventory problems, and, if time permits, Markov chains. Fall. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

652. Operations Research II **(3)**
Two 1½ hours of lecture. Deterministic or models applicable to managerial problems or systems analysis. Elements of Matrix Algebra, solving simultaneous linear equations, mathematical programming, classical optimization techniques, LaGrange multipliers. Linear programming transportation and allocation models, dynamic programming, network analysis and, if time permits, quadratic, parametric and integer programming. Fall. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

660. Information Processing Fundamentals **(3)**
The course presents problem solving and analytical structures, and practice in their application by use of a digital computer. Selected portions from the two general processing categories of numerical analysis and information systems are presented for discussion and study. The purpose is to develop an awareness with some understanding and proficiency in automated problem-solving systems. Spring.
Prerequisite: Integral calculus and proficiency in computer programming.

760. Computer Applications **(3)**
A course presenting some discussion and practice in the application of computers to the solution of complex large-scale problems. A study of simulation techniques provides the opportunity to apply a computer to the solution of problems normally considered outside the realm of classroom experience. A study of some programming systems permits the opportunity to see how computers are used to solve their own problems of efficiency concerned with time, space and reliability. Spring. Mr. C. N. Lee.
Prerequisites: APM 460 and APM 491 or the equivalents.

ENVIRONMENTAL SCIENCE (ENS)

797. Environmental Science Seminar **(2)**
Discussion of current topics and research related to environmental science. Fall and Spring.

798. Problems in Environmental Science **(Credit hours to be arranged)**
Specialized study in the problem areas of Environmental Science for graduate students. Tutorial conferences, discussions, seminars, workshops, and critiques scheduled as necessary. Comprehensive report required for some subjects. Fall and Spring.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring.

ENVIRONMENTAL AND RESOURCE ENGINEERING (ERE)

696. Advanced Topics **(2-3)**
Lectures, readings, problems, and discussions. Advanced topics as announced in the areas of environmental or resource engineering, building on one or more of the disciplines of the undergraduate curricula. Fall and/or Spring. Staff.

FOREST BIOLOGY (FBL)

540. Chemical Ecology **(3)**
Two hours of lecture and one hour of discussion. A treatment of biological phenomena incorporating elements of ecology, physiology and chemistry as a basis for development, behavior and survival. Emphasis is on intra- and inter-specific relationships involving chemical messengers at the organismal, population and community levels. Spring. Mr. Simeone.
Prerequisites: Organic chemistry, general ecology, general physiology.

615. Advanced Limnology **(4)**
Note: SUNY Albany No. BIO 516.
Eight weeks, two full days a week. Comprehensive analysis of primary and secondary producers in a selected series of Adirondack lakes and streams. Lecture discussion sessions serve to direct individual student projects detailing the flow of energy and circulation of matter in a variety of mountain habitats. Summer Sessions I & II, Cranberry Lake Biological Station. Mr. McNaught, SUNYA.
Prerequisite: BIO 202, 12 hours of biology.

621. Population Dynamics **(2)**
Note: SUNY Albany No. BIO 518.
Two full days per week for four weeks. Interrelationships of biotic and environmental factors that control population responses and interactions. Summer Session II, Cranberry Lake Biological Station.

670. Cytogenetics **(3)**
Two hours of lecture and one hour of seminar and discussion. Structure and behavior of chromosomes in animals and plants are considered. The effects of chromosomal aberrations and abnormal chromosome numbers on somatic and germ cell divisions, on the physiology and development of organisms with emphasis on human diseases and on populations including structure, speciation and evolution are discussed. Lecture demonstrations include tissue culture and cell hybridization methods for karyo-type analyses and somatic cell genetics. Fall (odd calendar years). Messrs. Lanier, Valentine and Neu.
Prerequisite: FBL 370 or permission of the instructors.

785. Histochemical Techniques **(3)**
One lecture and two labs. The techniques of the microtomecryostat, freeze-drying and freeze substitution, histochemical stains, and autoradiography in the elucidation of the constitution of cells and tissues. Spring (even calendar years). Mr. Tepper.
Prerequisites: Microtechnique and organic chemistry.

796. Topics in Biology **(1-3)**
A course offered by the faculty for students interested in biology. Check the Schedule of Courses for details. Fall and Spring. Staff.

835. Membranes and Biological Transport **(3)**
Two hours of lecture and one hour of discussion. Composition, structure, and physical properties of membranes. Membrane functions including transport, bioelectricity and cell compartmentalization. Specific transport processes in biological systems. Fall (alternate years). Mr. Schaedle.
Prerequisites: One semester of biochemistry and an advanced physiology course, or permission of the instructor.

997. Biology Seminar (1)
One hour of lecture-discussion per week. The course emphasizes current concepts and developments in biology. Fall and/or Spring. Staff.

BOTANY (BOTANY AND FOREST PATHOLOGY) (FBO)

510. Mycology (3)
Two hours of lecture, three hours of laboratory. Fundamentals of the morphology, taxonomy, cytology, life histories and ecology of fungi. Laboratory experience in culturing and identification of fungi. Fall. Mr. Griffin.

515. Systematic Botany (3)
Two hours of lecture, three hours of laboratory. Identification, nomenclature and classification of flowering plants with special emphasis on local flora and on developing the ability to classify the plants of any region. Fall.
Prerequisite: FBO 310 or permission of the instructor.

530. Plant Physiology (2)
Two hours of lecture. Internal processes and conditions in higher plants with emphasis on physiological and biochemical concepts. For students majoring in the biological sciences. Spring. Mr. Wilcox.
Note: Botany majors electing this course for their concentration must also take FBO 531.

531. Plant Physiology Laboratory (2)
Two lab sessions. Introduction to current methods and procedures of physiological research including nutrition, tissue culture, photosynthesis, respiration and hormonal regulation of growth. Spring. Mr. Schaedle.
Prerequisites: FBL 330, corequisite FBO 530, or permission of the instructor.

585. Plant Anatomy (3)
Two hours of lecture, three hours of laboratory. An introductory course in plant anatomy designed to familiarize the student with the organization and development of the primary and secondary plant body of higher plants. Spring. Mr. Tepper.
Prerequisite: FBO 100.

612. Phycology (2)
Note: SUNY Albany No. BIO 507.
Cranberry Lake Biological Station. Session II, every second or third summer. Two full days per week for four weeks. Study of the characteristic algae of selected Adirondack lakes and waters. SUNY Albany Staff.
Prerequisites: 15 hours of biology including general ecology and a course in the plant kingdom.

617. Adirondack Flora (2)
Note: SUNY Albany No. BIO 517.
Two full days a week for four weeks. Cranberry Lake Biological Station. Field study of the summer flora of the Adirondack Mountains. Session I. Mr. Baum.
Prerequisite: An elementary course in systematic botany.

625. Plant Ecology (3)
Two hours of lecture and discussion and one laboratory/discussion section per week. A first course in plant community ecology for beginning graduate students focusing on dynamics of community development and change and the processes of community analysis and description. Spring. Mr. Geis.
Prerequisite: A course in general ecology.

627. Bryoecology (2)
Two full days a week for four weeks. Field and laboratory work at the Biology Station. Study of the bryoflora of the major ecosystems of the Adirondack Mountain region.

Summer Session I, Cranberry Lake Biology Station. Mr. Ketchledge.
Prerequisites: Survey of the plant kingdom; systematic botany; general ecology.
Special requirement: Students must be prepared to go on two overnight trips to isolated areas.

630. Fungus Physiology **(3)**
Two hours of lecture, one hour of discussion. Principles of growth, reproduction and differentiation of the fungi emphasizing the role of the environment in controlling fungal processes. Spring (even years) Mr. Griffin.
Prerequisites: Two semesters of physiology or biochemistry.

636. Photosynthesis **(3)**
Two hours of lecture, one hour of discussion. Advanced study of photosynthesis on the cellular and organismal level. Specific topics will reflect basic concepts and current emphasis in this field. Fall of odd years.
Prerequisite: Two semesters of physiology or a course in biochemistry.

660. Phytopathology **(3)**
Two hours of lecture and discussion and three hours of auto-tutorial laboratory. Principles and concepts of plant pathology. Major diseases of ornamental plants, vegetable crops, fruit crops, field crops, and trees. This is an introductory plant pathology course for graduate students in all departments. Spring. Mr. Manion.

661. Principles of Forest Pathology **(3)**
Four hours of lecture, discussion and laboratory. Concepts and principles of tree diseases in relation to forest practices and practical experience in disease diagnosis and impact evaluation. P. D. Manion. Fall.
Prerequisite: FBO 360, 660, or consent of instructor.

662. Wood Deterioration by Microorganisms **(3)**
Two hours of lecture, three hours of laboratory/field trip. Major types of fungus defects of wood and its products and principles of control. Special emphasis on chemistry of wood decay, wood durability, toxicants, lumber discolorations, heartrots and decay in forest products. Fall. Mr. Silverborg.
Prerequisite: Organic chemistry, FBO 360, or consent of instructor.

715. Advanced Systematic Botany **(2-3)**
Lectures and laboratory. Field trips. Advanced study in the identification, nomenclature, and classification of flowering plants. Special emphasis on Gymnospermae, Compositae, and Gramineae. Fall.
Prerequisite: FBO 515 or equivalent.

725. Topics in Plant Ecology **(2)**
Two hours of seminar-discussion. An advanced course dealing with current research in plant community dynamics. May be repeated for additional credit. Fall.
Prerequisites: FBO 425 or 625 or consent of instructor.

733. Techniques in Plant Physiology **(2-4)**
Comprehensive study of techniques essential for research in plant physiology. Students may choose the instructors they wish to work with, and should consult the instructors for further details. Fall of every year. May be repeated for credit in different specialties. Staff.
Prerequisites: FBO 530 and 531 or an equivalent physiology course, biochemistry with laboratory, or consent of the instructor.

761. Topics in Phytopathology **(3)**
Two two-hour lecture-discussions. Discussions of specific phytopathological subjects. Topic selection is based on availability of expertise and will be announced in advance. Fall or Spring. Staff. This course may be repeated for credit in different specialties.

797. Botany Seminar **(1)**
Seminar discussions of subjects of interest and importance to the biology of plants. Fall and Spring. Staff.

798. Research in Forest Botany (Credit hours arranged according to nature of problem)
Advanced study in research problems in forest pathology, wood deterioration, tree physiology, anatomy, mycology, ecology, taxonomy and genetics. Typewritten report required. Fall and Spring. Staff.

810. Advanced Mycology, Homobasidiomycetes **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mrs. Wang.
Prerequisite: FBO 510. Course offered in odd calendar years.

811. Advanced Mycology, Heterobasidiomycetes **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mrs. Wang.
Prerequisite: FBO 510. Course offered in even calendar years.

812. Advanced Mycology, Ascomycetes **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mrs. Wang.
Prerequisite: FBO 510. Course offered in even calendar years.

813. Advanced Mycology, Myxomycetes, Phycomycetes, Fungi Imperfecti **(3)**
Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mrs. Wang.
Prerequisite: FBO 510. Course offered in odd calendar years.

825. Plant Population Ecology **(3)**
Three hours of lecture/discussion per week. An advanced course considering the dynamics of higher plant populations, evolutionary aspects of plant population interaction, and quantitative models. Spring.
Prerequisite: FBO 425 or 625, APM 615 or consent of instructor.

830. Physiology of Growth and Development **(2)**
Lecture. A study of the growth and development of plants and the physiological and biochemical processes that influence the development of form and structure in higher plants. Fall (even years). Mr. Wilcox.
Prerequisite: FBO 530, 585, and organic chemistry or permission of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

CHEMISTRY (FCH)

520. Nuclear and Radiation Chemistry **(2)**
The two one-hour lectures will cover the information required for the basic understanding of nuclear reactions, the types of radiation emitted, the instrumentation necessary to detect and measure this radiation, the principles of radioisotope tracer techniques and radiation chemistry which is the effect of radiation on organic systems. Visits to the Cornell Reactor and the Nuclear Medicine Department of the Upstate Medical Center will be arranged. Spring. Mr. Meyer.
Prerequisites: Physical, organic, and inorganic chemistry or by permission of the instructor.
Note: This course can be taken independently of FCH 521.

521. Nuclear Chemical Techniques **(1)**

The laboratory will consist of one four-hour laboratory class every two weeks, with one hour to be made up at the student's discretion to accommodate counting periods which extend over several weeks. A short movie by the AEC each week will be required for the sixth hour. The laboratory will give each student the opportunity to use the individual counting instruments, gain experience in the handling and preparation of radioactive samples and the use of the 1000 Curie-cobalt source in radiation chemistry. Spring. Mr. Meyer.

Prerequisite: Physical, organic and inorganic chemistry or permission of the instructor. Advance tentative registration is required.

Corequisite: FCH 520.

530. Biochemistry I **(3)**

Three hours of lecture. General biochemistry with emphasis on cellular constituents and metabolic reactions. The chemical, physical and biological properties of amino acids, proteins, carbohydrates and their intermediary metabolism will be discussed. The chemistry of enzymes, energy transfers and biological oxidations will also be covered. Fall. Mr. Walton.

Prerequisite: One year of organic chemistry.

Pre- or corequisite: One year of physical chemistry.

531. Biochemistry Laboratory **(2)**

Six hours of laboratory. This course will stress techniques used in biochemical research. Techniques used include various types of chromatography, electrophoresis, and spectrophotometry and methods involved in the isolation, purification and assay of enzymes. Fall. Mr. Walton.

Prerequisite: One semester of quantitative analysis with laboratory.

532. Biochemistry II **(3)**

Three hours of lecture. Topics discussed are: application of tracer techniques to biochemistry, the chemical and biochemical properties of lipids, theories on the origin of life, photosynthesis and the biosynthesis of steroids and terpenes, plant aromatics, amino acids, porphyrins and other aspects of nitrogen metabolism. Spring.

Prerequisites: FCH 530 and its pre- and corequisites.

539. Principles of Biological Chemistry **(3)**

Three hours of biochemistry with emphasis on their relationship to biology. Topics include basic metabolic pathways, structure and function of proteins, enzymes, and nucleic acids, energy relationships and biochemical control mechanisms. Fall. Mr. Walton.

Prerequisite: A two-semester course in organic chemistry is desirable, but a one-semester course is acceptable. This course is not open to chemistry majors.

540. Chemical Ecology

This course is the same as FBL 540. Refer to description on page 62.

551. Polymer Techniques **(2)**

One hour of lecture and discussion and three hours of laboratory; lab reports. Techniques of polymer preparation: free radical solution and emulsion polymerization, copolymerization. Molecular weight determination by light scattering, osmometry, viscosity, ultracentrifugation. Structure characterization by X-ray diffraction, electron microscopy, nuclear magnetic resonance, optical rotatory dispersion, polarized microscopy, stress-strain and swelling equilibrium. Fall. Mr. Sarko.

Prerequisites: One year of organic and one year of physical chemistry.

552. Polymer Processing and Technology **(3)**

Industrial methods of production and processing of polymeric materials such as fibers, films, plastics, elastomers, foams, composites, adhesives and coatings, including discussions on the correlation between polymer structure and polymer properties. Spring. Mr. Smid and Staff.

650. Physical Chemistry of Polymers I **(3)**
Three hours of lecture. Includes: thermodynamics of polymer solutions, phase equilibria, fractionation, structure-property relationships, elementary chain statistics, molecular geometry, network elasticity, polyelectrolyte theory and viscosity. Fall. Mr. Smith.
Prerequisites: One year of organic chemistry and one year of physical chemistry.

651. Physical Chemistry of Polymers II **(3)**
Three hours of lecture. Viscoelasticity. The glassy state and glass transition temperature. The crystalline state and crystallization kinetics. Characterization of structure and morphology of polymer solid states. Survey of structure and properties of native polymers. Spring. Mr. Sarko.
Prerequisites: One year of organic and one year of physical chemistry.

652. Organic Chemistry of Polymers I **(3)**
Three hours of lecture. A broad survey of the chemistry of polyfunctional molecules and methods for their conversion to high molecular weight materials. Synthesis of a variety of specialty polymers and chemical reactions on natural and synthetic polymers. Some relations between molecular structure and useful properties. Fall. Mr. Caluwe.
Prerequisites: One year of organic chemistry.

653. Organic Chemistry of Polymers II **(3)**
Three hours of lecture. Kinetics and mechanism of polymerization processes, with emphasis on addition homo- and copolymerization relations initiated by radical, cationic and anionic initiators. Mechanism of stereospecific polymerization. Structure of polymers. Reactions on polymers and their modification for specific end uses. Block and graft polymers. Spring. Mr. Smid.
Prerequisites: One year of organic chemistry and one year of physical chemistry.

680. Principles of Physical Chemistry I **(2)**
Two hours of lecture. Includes advanced discussions on the structure of atoms and molecules, chemical bonding, the structure and properties of matter in gaseous, liquid, and solid states. The laws of thermodynamics. Fall.
Prerequisite: One year of physical chemistry.

681. Principles of Physical Chemistry II **(2)**
Two hours of lecture. Includes advanced discussions on thermodynamics, chemical equilibrium, kinetic theory, chemical kinetics, and electrochemistry. Spring.
Prerequisite: FCH 680 or equivalent.

682. Principles of Organic Structure and Synthesis **(3)**
Three hours of lectures and discussion. A broad survey of strategies for constructing organic molecules and of physical and chemical methods for the elucidation of structure. Emphasis on material relevant to different chemical disciplines. Fall.
Prerequisites: One year of organic chemistry.

683. Principles of Organic Mechanisms **(3)**
Three hours of lecture and discussion. A broad survey of organic reaction mechanisms and of techniques and methods used in their elucidation. Emphasis on material relevent to different chemical disciplines. Spring.
Prerequisite: One year of organic chemistry.

796. Special Topics in Chemistry **(1-3)**
(Credit hours arranged according to nature of topic)
Lectures, conferences and discussion. Advanced topics in physical chemistry, organic chemistry, or biochemistry. Fall and Spring. Staff.

798. Research in Chemistry
(Credit hours arranged according to nature of problem)
Independent research in physical and organic chemistry of synthetic polymers, physical and organic chemistry of natural polymers, organic chemistry of natural products, ecological chemistry and biochemistry. One typewritten report required. Fall and Spring. Staff.

830. Topics in Plant Biochemistry **(3)**
Three hours of lecture and discussion. Covers topics in biochemistry unique to plants, including photosynthesis, biosynthesis of cellwall components, phenolics, terpenes, nitrogen metabolism, structure and function of plant hormones, biochemistry of differentiation and growth regulatory mechanisms. Spring (alternate years). Mr. Walton.
Prerequisites: FCH 530, FCH 532, or equivalents.

850. Organic Chemistry of Polymers **(3)**
Three hours of lecture, discussion and recitation. A broad survey of polymer forming reactions and polymeric structures. Special problems in stereochemistry, polymerization mechanisms and the synthesis of a variety of specialty polymers. Some relations between molecular structure and useful properties. Spring. Mr. Caluwe.
Prerequisites: One year of organic chemistry and FCH 450.

855. Physical Chemistry of Polymers **(3)**
Three hours of lecture and discussion. Introduction to statistical mechanics of polymers: general problem of random flight, chain statistics and conformations, partition functions: network statistics and rubber elasticity, birefringence, swelling, crystallization. Scattering phenomena: theory of light scattering, scattering from a sphere, scattering from liquids and solids, anisotropic scattering, X-ray scattering. Fall or Spring. Mr. Sarko and Mr. Smith.

884. Organic Natural Products Chemistry **(3)**
Three hours lecture. The chemistry of terpenoids, steroids and alkaloids with an emphasis on the determination of structure by both modern instrumental methods and chemical degradation. Biogenetic considerations and the confirmation of structure by synthesis are covered. Fall or Spring. Mr. LaLonde.
Prerequisite: One semester of advanced organic chemistry.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

997. Seminar **(1)**
Seminars scheduled weekly; an average of twenty to thirty seminars are given annually. Discussion of recent advances in chemistry. Credit is given only once to a student. Fall and Spring. Mr. Smith.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

ENGINEERING (FOREST ENGINEERING) (FEG)

563. Photogrammetry I **(3)**
Two hours of lecture and discussion, three hours of laboratory and discussion. Basic photogrammetric and photo interpretation concepts as a means of acquiring reliable data for engineering and management planning. Potentials, limitations, instrumentation, and unique requirements are considered. Fall and Spring. Mr. Brock.
Prerequisite: FEG 271 (or FEG 371 concurrent) or equivalent.

640. Water Resource Systems **(3)**
Three hours of lecture and discussion per week. Fundamentals of the systems approach to complex water resource problems. Characteristics of water resource systems, related to systems engineering methodologies. Quantitative and qualitative subsystems are

considered in a technical nature which exposes the socio-legal-political interfaces of water resource decisionmaking. Fall and/or Spring.

Prerequisite: FEB 340 or equivalent.

652. Remote Sensing Interpretation (3)

Two hours of lecture and three hours of laboratory per week. Introduction with a qualitative emphasis to the fundamentals of acquiring, analyzing and utilizing remote sensing data in the performance of natural resource inventories, environmental quality surveys, site development studies and land use analyses. Oriented for multidisciplinary participation. Fall and/or Spring. (Not open to students having previous credit for FEG 352). Mr. Lillesand.

Prerequisite: Physics and calculus or consent of instructor.

655. Remote Sensing Measurements (3)

One hour of lecture, one hour of discussion and three hours of laboratory comprising an in-depth coverage of the theory, design and application of remote sensing systems and techniques employed to obtain precise spectroradiometric measurements in vegetation surveys, site engineering, data acquisition endeavors and environmental monitoring efforts. Photographic and non-photographic systems are considered. A variety of field and laboratory measurement endeavors employing precision remote sensing equipment is included. Fall. Mr. Lillesand.

Prerequisite: FEG 352 or 652 and FEG 363 or 563 or consent of instructor.

660. Theory of Errors and Adjustments (3)

The theory of errors and adjustment of observations oriented toward geodesy and photogrammetry. Topics include error definitions, weighted observations, method of least squares, matrix algebra in adjustments, variance-covariance matrix, the error ellipse and the general case of adjustment. Fall or Spring. Mr. Brock.

Prerequisite: Calculus; a beginning course in statistics.

664. Photogrammetry II (3)

Mathematical theory of photogrammetry including space resection, orientation and intersection. The theory and use of photogrammetric analogue computers in providing resource engineering maps. Fall. Mr. Brock.

Prerequisite: FEG 563 or equivalent.

665. Terrestrial and Nontopographic Photogrammetry (3)

Two hours of lecture, three hours of laboratory per week. The theory and applications of terrestrial and nontopographic photo measurements. Photo-Theodolites, short-focus cameras and microscopes are used and calibrated to provide meaningful quantitative data from photographs. Spring. Mr. Brock.

Prerequisites: FEG 363 and APM 360 or equivalent.

674. Geometric Geodesy (3)

An introductory graduate level course for those without previous background in theoretical geodesy. Topics covered include position determination for short and long lines on the ellipsoid, the ellipsoidal triangle, the parametric equations, three-dimensional geodesy, and mappings of the ellipsoid. Fall. Mr. Bender.

Prerequisite: Permission of the instructor.

675. Astronomic and Gravimetric Geodesy (3)

An introductory graduate level course in geodetic astronomy and the gravity field of the earth. Topics covered include updating star positions; precise time keeping; position determination by natural and artificial satellites; the fundamental concepts of gravimetric geodesy, including the potential function; attraction; undulations of the geoid and deflections of the vertical. Fall. Mr. Bender.

Prerequisite: FEG 674.

760. Analytical Photogrammetry I (3)
Two hours of lecture, three hours of laboratory per week. Mathematical theory of photogrammetry including space resection, orientation, intersection and aerial triangulation. Fall. Mr. Brock.
Prerequisites: FEG 363 and APM 360 or equivalent.

761. Analytical Photogrammetry II (3)
Two hours of lecture, three hours of laboratory. A continuation of FEG 760 leading to more extensive analytical solutions with frame and nonconventional photography. The distortions present in photographs are analyzed and camera and comparator calibrations are treated. Spring. Mr. Brock.
Prerequisite: FEG 760.

762. Instrumental Photogrammetry I (3)
Two hours of lecture, three hours of laboratory. The theory and practice of extracting information from photographs with the aid of photogrammetric plotters. Fall. Mr. Brock.
Prerequisite: FEG 363 or equivalent.

763. Instrumental Photogrammetry II (3)
Two hours of lecture, three hours of laboratory. The major subjects of study are photogrammetric optics, the theory and design of optical and mechanical plotters and automatic mapping systems. Spring. Mr. Brock.
Prerequisite: FEG 762 or permission of instructor.

797. Seminar (1)
Literature surveys and seminars on topics of forest engineering interest and importance. Subjects to be generated by faculty and students and to be announced prior to registration. Fall and Spring. Staff.

798. Research in Forest Engineering
(Credit hours arranged according to nature of problem)
Independent research topics in Forest Engineering for graduate students who desire specialized knowledge or research experience. Tutorial conferences, discussions and critiques scheduled as necessary. One typewritten report (original and one carbon) required. Fall and Spring. Staff.

899. Master's Thesis Research (Credit hours to be arranged)
Research and independent study for the master's thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research (Credit hours to be arranged)
Research and independent study for the doctoral dissertation. Fall and Spring. Staff.

ENTOMOLOGY (FOREST ENTOMOLOGY) (FEN)

560. Environmental Toxicology of Insecticides (2)
Two hours of lecture. Basis of action of insecticides in living systems, behavior of insecticides and microtoxicants in environment, interaction of insecticides and biological systems. Fall.
Prerequisite: FBL 330 or equivalent course in physiology or biochemistry.

580. Insect Morphology (3)
Two hours of lecture, three hours of laboratory. A comparative study of the external morphology of insects emphasizing evolutionary trends, especially modifications of homologous structures. Topics of special importance include intersegmental relationships, feeding, sensory mechanisms, locomotion and reproduction. Spring. Mr. Kurczewski.
Prerequisite: FEN 350.

610. General Insect Taxonomy (3)
Two hours of lecture, three hours of laboratory. Identification and classification of the important orders and families of insects; acquaintance with pertinent taxonomic literature

and use of keys; and understanding of evolutionary principles and concepts and a knowledge of systematic theory and practice. Insect collection required. Fall. Mr. Kurczewski.
Prerequisites: FEN 350, FEN 580.

620. Aquatic Entomology (3)
Two hours of lecture, three hours of laboratory. The biology, ecology and identification of fresh water insects, with emphasis on the role of aquatic insects in the hydrobiome. Fall. Mr. Brezner.
Prerequisite: FEN 350 or its equivalent.

630. Insect Physiology (3)
Two hours of lecture, three hours of laboratory. Study of the life processes in insects; introduction to modern physiological instrumentation and laboratory methods. Spring. Mr. Brezner.
Prerequisite: FBL 330.

660. Insecticide Toxicology Laboratory (2)
One hour of discussion and three hours of laboratory. Laboratory experiments in mode of action and behavior of insecticides, biological and instrumental analysis of insecticides including tracer analyses. Spring, odd years. Mr. Nakatsugawa.
Prerequisite: FEN 560 or equivalent and consent of instructor.

720. Population Dynamics of Forest Insects (3)
Two hours of lecture, one hour seminar. Interacting environmental factors which influence the relative abundance and distribution of forest insects, ecological principles as applied to problems in forest entomology, and pest management. Introduction to theories of population regulation and the study of the dynamics of forest insect populations; individual seminar. Fall. (even years). Mr. Allen.
Prerequisites: FEN 350, FBL 320, APM 491, or equivalents.

796. Special Topics in Forest Entomology
(Credit hours arranged according to nature of work)
Special instruction, conference, advanced study, and research projects in the fields of insect toxicology, insect physiology, taxonomy of immature insects, phases of biology and ecology of insects. Typewritten report required in some fields. Fall and Spring. Staff.

797. Seminar (1)
One hour of conference per week. Assigned reports and discussion of topics in entomology. Fall and Spring. Mr. Nakatsugawa and Staff.

798. Research Problems in Forest Entomology
(Credit hours arranged according to nature of problem)
Comprehensive report required in some projects. Fall and Spring. Staff.

810. Advanced Insect Taxonomy (3)
Two hours of lecture, three hours of laboratory. Methods, procedures, and concepts of systematics. Examples and material will be drawn from among important groups of forest insects. Fall. Mr. Lanier.
Prerequisites: FEN 580 and FEN 610.

860. Advanced Toxicology of Insecticides (3)
Three hours of lecture and discussion. Review of current topics in toxicology of insecticides and related foreign compounds. Fall. Mr. Nakatsugawa.
Prerequisite: FEN 560, FCH 530 **and** consent of instructor.

899. Master's Thesis Research (Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

FOREST ZOOLOGY (FZO)

520. Terrestrial Community Ecology **(3)**
Two hours of lecture, three hours of laboratory. Relations of terrestrial animals to their physical, chemical and biological environment. Emphasis on community principles, succession and terrestrial adaptations. Fall. Mr. Dindal.
Prerequisite: A course in basic ecology.

525a. Physical and Chemical Limnology **(1)**
Modular format, two hours of lecture per week for first seven weeks of fall semester. An introduction to the physics and chemistry of inland waters with particular emphasis on lakes.
Prerequisites: Junior standing, an introductory physics course and an introductory chemistry course. Fall. Mr. Werner.

525b. Introduction to Biological Limnology **(1)**
Modular format. Two hours of lecture per week for last seven weeks of fall semester. An introduction to the biology of inland waters. Particular emphasis is placed on the aquatic environment as a habitat and the effect of changes in this environment on the structure and function of the biological communities contained therein.
Prerequisites: FZO 525a. Fall. Mr. Werner.

525c. Limnology Laboratory **(1)**
One laboratory or field trip per week. An introduction to limnology techniques and the taxonomy of aquatic organisms. Field trips to local aquatic habitats. FZO 525a. and FZO 525b. must be taken concurrently or previously. Fall. Mr. Werner.

620. Invertebrate Symbiosis **(3)**
Two hours of lecture and one three-hour laboratory. An introduction to the ecology and evolution of interspecific relationships of invertebrates. Spring, even years. Mr. Dindal.
Prerequisites: FBL 320, FZO 411.

626. Ecology of Adirondack Fishes **(2)**
Cranberry Lake Biological Station, Session II, every third summer. Half time for four weeks. Study of the ecology of fishes, with detailed individual investigation of the ecology of Adirondack fishes. Mr. Werner.
Prerequisite: FZO 416.

627. Field Ornithology **(2)**
Note: SUNY Albany, No. BIO 601
Two full days per week for four weeks. Field study of the ecology, distribution and behavior of birds of the Adirondack region. Techniques used in conducting field studies in avian biology will be emphasized. Summer Session A, Cranberry Lake Biological Station. Staff, SUNY at Albany.

628. Vertebrate Population Ecology **(3)**
Two hours of lecture and one three-hour laboratory per week. Fundamental parameters of population structure and change with emphasis on vertebrate species. Spring. Mr. Ringler.
Prerequisite: A course in general ecology.

635. Behavioral and Physiological Ecology **(3)**
Two hours of lecture, one hour of discussion. An examination of the concepts of animal adaptations to ecological change from a behavioral point of view. Particular emphasis will be placed on the role the environment plays in shaping the behavior of a given species.

Behavioral and physiological responses to environmental conditions will be treated as a continuum. Spring Semester, odd-numbered years. Mr. Muller-Schwarze.

650. Biology and Management of Waterfowl (2)
A consideration of the identification, life history, ecology and economic importance of waterfowl of the Atlantic Flyway. The management of local, flyway and continental waterfowl populations, including the establishment of hunting seasons, will be discussed. One Saturday field trip. Fall, odd years. Mr. VanDruff.

670. Vertebrate Behavior (3)
Two hours of lecture, three hours of laboratory. In-depth study of the major concepts of animal behavior associated with behavioral genetics, development orientation and social behavior. Spring.
Prerequisite: FZO 570.

700. Forest Zoology Trip (2)
A 7 to 10 day trip to (1) agencies engaged in zoological research, management, and administration, or (2) regions or areas of unusual biological interest. A final report is required. Estimated student expense, $75.00. Fall or Spring. Staff.

720. Topics in Soil Invertebrate Ecology (3)
Two one-hour lecture-discussion periods and a three-hour laboratory. Study of literature relating to soil invertebrate microcommunities; taxonomy, culturing, and collection methods of soil fauna; student will conduct an individual research problem. Spring. Odd years. Mr. Dindal.
Prerequisite: Permission of instructor.

725. Zoogeography (3)
Two hours of lecture, three hours of laboratory. Geographic distribution of vertebrate animals, factors determining their distribution and nature of range occupied. Fall. Alternate odd years.

727. Seminar in Aquatic Ecology (1)
Two hours of lecture and discussion. A seminar to explore in some depth areas of current research in aquatic ecology. Fall. Even years. Messrs. Werner and Ringler.
Prerequisite: Six credits in Aquatic Ecology.

750. Advanced Wildlife Management (3)
Two hours of lecture, three hours of laboratory. Advanced wildlife management with emphasis on regional and administrative wildlife problems. Extended trips (two weekend trips) are required. Spring. Mr. Chambers.
Prerequisite: FZO 455 or permission of the instructor.

797. Forest Zoology Seminar (1)
Two hours of discussion and assigned reports on current problems and new developments in forest zoology. Fall and/or Spring. Staff.

798. Problems in Forest Zoology (Credit hours to be arranged)
Hours to be arranged. Individual study of special problems in forest zoology. One typewritten report (original and one carbon) required. Fall and/or Spring. Staff.

835. Invertebrate Physiology (3)
Two hours of lecture, three hours of laboratory. A study of the physiologic mechanisms employed by invertebrates other than insects in coping with the exigencies of their environment. Fall or Spring. Alternate years. Mr. Hartenstein.
Prerequisites: FZO 411 and FZO 330.

899. Master's Thesis Research (Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

950. Topics in Wildlife Biology **(1-3)**
Hours to be arranged. Group study of a wildlife management topic. Fall or Spring. Mr. Chambers.
Prerequisite: Six credits of wildlife management courses.

970. Topics in Animal Behavior **(2)**
Two hours of lecture and discussion. A seminar-type course designed to explore in depth selected and controversial subject areas in animal behavior. Fall or Spring.
Prerequisite: FZO 670 or equivalent.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

LANDSCAPE ARCHITECTURE (LSA)

522. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Studio problems, research, drafting and field trips. Concentration on complex urban problems. Concern for social and psychological considerations of the individual and large groups of people, their interaction and resultant forms of the environment. Spring.
Prerequisite: Permission of instructor.

524. Experimental Landscape Design Studio V **(16)**
48 hours per week. The articulation of the study proposal established in LSA 425, as approved by faculty, through research, readings, field study with graphic and written documentation, and group discussion. Academic study in an off-campus location in an area of landscape architectural significance, as described and delineated in a student-prepared proposal approved by the faculty. Not available for graduate credit. Fall or Spring.
Prerequisites: LSA 425 or equivalent and LSA 423 or permission of instructor.

525. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Investigation of a problem in landscape architecture as proposed by the student and conducted in conjunction with faculty advisor. Spring.
Prerequisite: Permission of instructor.

527. Landscape Design Studio VI **(4)**
Twelve hours studio per week. Studio problems, research, reports and field trips. Concentration on regional landscape problems, the techniques of their analysis and derivation of their significance to the practice of landscape design. Spring.
Prerequisite: Permission of instructor.

529. The Major Elements of Environmental Design **(3)**
Lectures, readings, discussions and studios. The course presents an introductory survey of environmental design methods and associated skills and techniques. While studio work is engaged, no design background is required. Fall.

530. Herbaceous Plant Materials **(2)**
Two hours of lectures, study problems, assigned readings and field trips per week. Identification, understanding and design use of nonwoody plants. Fall.
Prerequisite: Permission of instructor.

532. Woody Plant Materials **(3)**
Three hours of lecture per week. Field study, lectures, slide presentations and readings. An elective course providing opportunity for extension of basic knowledge in the identification and design of woody plant materials in professional practice. Fall or Spring.
Prerequisites: LSA 533 and LSA 432 or permission of instructor.

533. Plant Materials **(3)**
Field trips and discussion. Ornamental woody plant identification. Observation and sketches of outstanding examples of planting design. Three weeks, Summer Session.
Prerequisite: Permission of instructor.

542. Highway Location and Design **(3)**
Two hours of lecture, three hours of studio per week. Lectures, assigned reading, studio projects, field trips. Environmental, engineering and human factors which determine highway location and design, particularly as they relate to landscape architectural concerns. Location, alignment, geometric design, drainage, roadbed construction, pavements, roadside development. Fall or Spring.
Prerequisites: LSA 343 and 440 or permission of instructor.

545. Professional Practice Studio II **(2)**
Three hours of studio, one hour of recitation per week. Studio problems research, discussion and recitation sessions on the processes and methods of office practice. Emphasis on all aspects of site-development. Spring.
Prerequisite: Permission of instructor.

547. Principles of Professional Practice **(2)**
Two hours of lecture per week. Lectures, assigned readings, reports, cost estimates, specifications, contracts, professional ethics, registration laws, professional practice. Spring.
Prerequisite: Upperclass standing.

562. Architecture **(3)**
Two hours of lecture, three hours studio. Discussion and investigation of the principles of architectural design and procedures of architectural practice. Functional building systems coupled with site and program considerations as to their relative impacts on architectural form. Spring.
Prerequisite: Permission of instructor.

595. Selected Readings in Landscape Architecture **(1-3)**
Exploration of selected readings in depth with individual independent study upon a plan submitted by the student and related to credit hours assigned. Upon approval of the instructor, the student may systematically investigate some subject area encountered in regularly scheduled courses or may initiate research on a variety of subject areas of determined relevance. Fall, Spring and Summer Session.
Prerequisite: 5th year status or permission of instructor.

597. Landscape Architecture Seminar **(3)**
Three hours of seminar per week. Discussion of current social, political, cultural and technological problems as to their relationship to the physical environment. Fall and Spring.
Prerequisite: Permission of instructor.

598. Research Problem **(1-3)**
Independent study of selected areas of environmental interest. Emphasis on a self-disciplined study, development of procedures and techniques to be employed in environmental design and planning. Engagement with specific sites and problems as proposed for study by individual communities. Fall and Spring. Enrollment at periodic intervals throughout the semester.
Prerequisite: Permission of instructor.

620. Graduate Studio I **(4)**
Twelve hours of studio per week. Disciplines and techniques used by the landscape architect in problem identification, analysis and solution strategies. Emphasis is on processes, not on product. Fall.
Prerequisite: Permission of instructor.

650. Determinants of Urban and Regional Land Use (3)
Three hours of discussion per week. This course will provide an introduction to social science theories of land use patterns. The nature of social, economic and political processes are explored in order to determine how the relationship of such factors effects the spatial development of the physical environment. Understanding of these processes provide a basis for urban and regional planning. Fall.
Prerequisite: Permission of the instructor.

651. Process of Urban and Regional Planning (3)
Three hours of seminar per week. The purpose of this course is the introduction of planning as a process of decisionmaking and to familiarize graduate students with its scope and content. The course relies upon lectures and readings to develop introductory knowledge as well as seminars and discussions to cover the constitutional basis, tools, and techniques and the current directions of planning. Spring.
Prerequisite: Permission of instructor.

653. Environmental Land Use Planning (3)
An introduction to the interdisciplinary techniques and emphasis of environmental land use planning. Consideration of the underlying ecological and planning philosophies. Readings and discussions are used in order to familiarize students with the disciplines involved and the process of data analysis, synthesis and plan formulation. Case studies and research projects used to enhance understanding.
Prerequisite: Permission of instructor. Fall and Spring.

654. Urban and Regional Open Space Planning (3)
Three hours of seminar per week. An introduction of concepts of open space planning related to urban, suburban, new town and regional land use. An investigation of contemporary methods for open space preservation through private and municipal efforts will include inventory and analysis techniques for identifying community needs and physical resources. Fall.
Prerequisite: Permission of instructor.

655. Public Policy and the Urban Environment (3)
Three hours of seminar per week. This course investigates public policy decisions as they affect the physical and social patterns of the environment. Seminar discussions based on readings and case study investigation. Spring.
Prerequisite: Permission of the instructor.

697. Seminar—Topics and Issues of Physical Environment (2)
Current topics for discussion are selected in order to acquaint the entering graduate student with a generalized view of the issues of the physical environment. Fall.
Prerequisite: Permission of the instructor.

699. Research Methods and Techniques (2)
Research methods, techniques and information sources pertinent to landscape architecture are surveyed and evaluated. Spring.
Prerequisite: Permission of instructor.

711. Human Behavior and Environmental Form (3)
Consideration of the nature and dynamics of people's movements in space as clues to their relationship with their environments. An examination of the basic social and behavioral concepts that relate to the human use of the urban environment. Concepts such as behavior patterns, territoriality, cognitive mapping, urban images, preference, neighborhood and community will be explored within the framework of "social space." The implications of such behavioral studies in the design of the environment will be considered.
Prerequisite: Permission of the instructor. Fall and Spring.

720. Graduate Studio II **(4)**
Twelve hours of studio per week. A multidisciplinary approach to the solution of one or more environmental problems of concern to the landscape architect. Because of the multivariable complexity of environmental problems, students pursuing various degree programs are invited to utilize this studio. Spring.
Prerequisite: LSA 620 or permission of instructor.

721. Graduate Studio III **(4)**
Twelve hours of studio-workshop per week. This is an extension of LSA 720, Graduate Studio II, with the engagement of additional problems. Fall.
Prerequisite: LSA 720 or permission of instructor.

730. Plant Materials IV **(2)**
Lecture, field work, trips. Special study of woody and herbaceous plant materials, greenhouse operation and other horticultural practices. Spring.

731. Plant Materials **(3)**
Seminars, individual conferences, field trips, readings. Guided individual study in aspects of plant materials related to landscape architecture. Fall or Spring.
Prerequisite: LSA 730 or permission of instructor.

740. Landscape Architectural Construction **(3)**
Lectures, drafting. Detailed study of special landscape construction problems. Preparation of estimates, contracts and specifications. Fall.
Prerequisite: LSA 542.

750. City and Regional Planning **(3)**
An introduction to methods of city and regional planning through the study of contemporary planning problems. Readings, discussions and reports. Fall and Spring.
Prerequisite: Permission of instructor.

752. Methods of Urban and Regional System Dynamics **(3)**
Lectures and workshop. The major concerns of this course are application of system dynamics; basic principles of system dynamics; and system dynamics modeling. This method is investigated as a useful tool in modeling many landscape architectural and planning problems. No prior computer experience is necessary. Fall.
Prerequisite: Permission of instructor.

757. Methods of Corridor Location **(3)**
Three hours of lectures per week. This course emphasizes study of corridor types, traditional economic determinism, and the emergence of environmental, aesthetic, and social concerns. Landscape architectural methods for corridor location and evaluation are reviewed and compared. These methods include graphic overlays, automated data bank, unified scoring systems, and multiple accounts. Students will engage a course project. Spring.
Prerequisite: Permission of instructor.

797. Seminar **(2)**
Two hours per week. Discussion of current topics, trends and research related to landscape architecture, planning, and management. Fall and Spring.
Prerequisite: Permission of instructor.

798. Research Problem
(Credit hours to be arranged according to nature of problem)
Special study of assigned problems relating to landscape architecture or planning, with emphasis on critical thinking. Fall and Spring.
Prerequisite: Permission of instructor.

799. Research Topics **(2)**
Research trends and current research needs pertinent to landscape architecture are reviewed and evaluated. The student develops a topic area and a proposed strategy for terminal study. Fall.
Prerequisite: LSA 699.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring.

PAPER SCIENCE AND ENGINEERING (PSE)

575. Unit Operations I: Fluid Mechanics and Heat Transfer **(3)**
Three hours of lecture and four hours of recitation per week for the first 9 weeks of the semester. The study of momentum and heat transfer. Pipeline and duct design, pump and blower selection, flow measurement, open channel flow, heat transfer by conduction, convection, radiation, including equipment design and selection. Fall. Mr. Stenuf.
Prerequisites: PSE 370 or equivalents.

576. Unit Operations II: Process Control and Mass Transfer **(2)**
Two hours of lecture and four hours of recitation per week for the last 6 weeks of the semester. The study and application of measuring means, remote signal transmission, and control elements. Response to signals, lag, dynamic error, cycling and other phenomena of process control are discussed in relation to the standard modes of control, including two-position, single-speed floating, proportional, proportional-speed floating, proportional-reset, proportional-reset-rate, cascade control, relation of the process variables to open and closed loop computer applications.
The fundamentals of mass transfer humidification and air conditioning as applied to industry and as found in the environment—climate and weather conditions. Fall. Mr. Stenuf.
Prerequisite: PSE 575.

578. Unit Operations III: Mass Transfer **(3)**
Three hours of lecture and four hours of recitation per week for the first 9 weeks of the semester. The study of mass transfer and application to the design and operation of equipment for drying, gas absorption, distillation and extraction. Each operation is treated as a practical unit complete with application of heat transfer, fluid flow, thermodynamics and instrumentation. Spring. Mr. Stenuf.
Prerequisite: PSE 576.

579. Unit Operations IV: Recovery Processes Operations **(2)**
Three hours of lecture and four hours of recitation per week for the last 6 weeks of the semester. The study of industrial recovery processes operations including evaporation, filtration, sedimentation, centrifugation, small particle technology and fluidization, and reverse osmosis. Each operation is treated as a practical unit complete with application of heat transfer, fluid flow, thermodynamics and instrumentation. Spring. Mr. Stenuf.
Prerequisite: PSE 576.

661. Pulping Technology **(4)**
Two hours of lecture and six hours of laboratory plus evaluation of literature, independent project planning and/or laboratory study. Discussion of pulping and bleaching processes. Effects of chemical and physical variables on the wood components and pulp properties; chemistry involved. Experiments in pulping and bleaching, and pulp evaluation. Fall. Mr. Gorbatsevich.
Prerequisites: PSE 370, CHE 346, and CHE 356.
Note: A student may not enroll in or receive credit for both PSE 461 and PSE 661.

665. Paper Properties **(5)**
Three hours of lecture, six hours of laboratory and discussion plus evaluation of literature, independent project planning and/or laboratory study. Evaluation and study of the physical, optical, and chemical properties of paper and the inter-relationships existing

between paper manufacturing methods, papermaking additives, test results and the ultimate properties desired in the finished paper. Fall. Mr. Bambacht.

Prerequisites: Consent of instructor.

Note: A student may not enroll in or receive credit for both PSE 465 and PSE 665.

666. Paper Coating and Converting **(3)**

Two hours of lecture and three hours of laboratory plus evaluation of literature, independent project planning, and/or laboratory study. Evaluation and study of the various coating materials and processes used by the paper industry. Introduction to polymers and their use in converting operations. Study of materials and equipment used in converting operations, fundamentals and parameters which control their use, effects on final properties of papers. Spring. Mr. Bambacht.

Prerequisites: PSE 465 or consent of instructor.

Note: A student may not enroll in or receive credit for both PSE 466 and PSE 666.

775. Industrial Thermodynamics **(3)**

The study and application of thermodynamics, including the first and second law, phase relationships, thermochemistry, the production of work and equilibrium relationships. Fall. Mr. Stenuf. Course given in even calendar years.

Prerequisites: CHE 346, CHE 356, or equivalent.

796. Special Topics **(1-3)**

Lectures, conferences and discussions. Advanced topics in chemical engineering, chemistry and physics as related to fibers, pulps, and paper. Fall and Spring. Staff.

797. Seminar **(1)**

Discussions of assigned topics in fields related to pulp and paper technology. Fall and Spring. Staff.

798. Research in Pulp and Paper Technology
(Credit hours arranged according to nature of problem)

Hours to be arranged. Problems in pulp and paper technology are assigned to properly qualified graduate students. A technical report is required. Fall and Spring. Staff.

Prerequisites depend upon nature of problem.

899. Master's Thesis Research **(Credit hours to be arranged)**

Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**

Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

RESOURCE MANAGEMENT AND POLICY (RMP)

588. The Law of Natural Resource Administration **(3)**

Three hours of lecture and discussion. An introduction to the law concerning the procedures, powers and judicial review of public agencies responsible for the management of natural resources. Topics will include the extent of an agency's rule-making power and the rights of aggrieved parties to appeal from agency decisions. Spring. Mr. Horn.

Prerequisite: ERM 460 or equivalent course in public administration.

601. Introduction to Multiple Use Management **(3)**

Three hours of lecture and discussion. Goals, processes and problems of timber, recreation, wildlife and watershed management are considered individually and in a multiple-use context. Fall. Staff.

606. Management Principles and Processes **(3)**
Three hours of lecture and group discussion. The central focus of this course is on decisionmaking, organization and information theories as they relate to the total management process. Spring.
Prerequisite: Basic understanding of management functions and processes as found in ERM 360. Available to qualified seniors.

611. Economics of the Forest Business **(3)**
Two hours of lecture, three hours of laboratory. Economic evaluation of alternative uses of land, labor and capital in the operation of forest properties and related marketing and processing enterprises. Emphasis is on application of principles and methods of economic analysis. Part of the term is spent in appraising a forest property and preparing a plan for its operation. Complementary to instruction in ERM 456. Spring. Mr. Christiansen.
Prerequisite: ERM 463 or permission of the instructor.

629. Environmental Impact: Principles and Strategies **(3)**
Three hours of lecture and discussion. Principles and theory of environmental impact and statements of impact as required by Federal law. Administrative procedures for review and evaluation. Procedural strategy and effective constitution of statements for various governmental levels. Means of obtaining sources of authoritative information. Fall and Spring. Mr. Black.

640. Analysis and Control of Forestry Operations **(3)**
Two hours of lecture, three hours laboratory. Applications of scientific methods to management decision problems of forestry operations with emphasis on data sources and reliability, model formulation, inventory control, equipment replacement, simulation, and critical path scheduling and costing. Fall.
Prerequisites: APM 491 or equivalent, ERM 373 and computer programming.

641. Soil and Water Conservation **(3)**
Three hours of lecture and discussion. An integrated examination of the many aspects of the field of water and related land resource conservation in the United States. Topics include the evaluation and present status of planning, organizational, economic and legal constraints on the development of policies and programs of the Federal agencies, state and local government and private units. Fall. Mr. Black.
Prerequisite: Permission of the instructor.

642. Water Quality Management **(3)**
Three hours of lecture and seminar per week. The review of the ethical, historical, legal and technical basis for water quality management. Investigation of public policy on the international, Federal, state and local levels and the administrative methods and programs used to implement policy. Fall. Mr. Hennigan.

643. Urban Water Management **(3)**
Three hours of lecture and seminar per week. A review of the role of urban water management in water resources management. The problems and issues of providing water utilities services of water supply, drainage and waste water facilities including such considerations as planning, financing, local government, intergovernmental relations, state and Federal role, water institutions and applicable law. Spring. Mr. Hennigan.

650. Forestry and Economic Development **(3)**
Three hours of lecture and discussion. Study of the role of forest resources in the process of economic development. Characteristics of forest resources which are important for economic development are analyzed in detail. Interrelationships between biological, technological and institutional factors are stressed. Fall. Mr. Petriceks. Offered to seniors and graduate students in environmental and resources management. Open to others by permission of instructor.
Prerequisite: ERM 463 or its equivalent.

662. Land Use Economics (3)
Three hours of lecture/discussion per week. Study of the theory and methods of land use economics and the application of economic analysis to open space and regional planning. Emphasis is on understanding basic concepts, developing of operational methods and data sources. Case studies, outside readings, and guest speakers are utilized. Fall. Mr. Canham.
Prerequisite: One course in macroeconomics and one in microeconomics and permission of instructor.

670. Economics of Nonmarket Goods (3)
Group discussion, lectures, guided readings, case studies and student projects on the economic aspects of watershed management, fish and wildlife management, and outdoor recreation. Major topics include theories of valuation and application to nonmarket goods, cost analysis for nonmarket goods, and measurement of regional impacts. Spring.
Prerequisites: ERM 204 or 206 or equivalent, knowledge of basic statistical analysis, and six hours or more of resource management coursework.

672. Open Space Planning (Recreation) (3)
Three hours of lecture/discussion per week. Study of methods and techniques applicable to open space planning in nonurban areas. Survey of literature and current research. Open space standards, classification systems and inventory methods. Development of plans for large scale recreation areas, and inclusion of recreation into regional plans. The interrelationship and conflicts between resource utilization/development and recreation/aesthetics reviewed through case studies. Fall. Mr. Gratzer.
Prerequisite: One course in outdoor recreation, one course in planning, and permission of instructor.

675. Social Psychology of Leisure Behavior (3)
Three hours lecture and discussion. Introduction to theory and research findings dealing with the sociological and psychological aspects of leisure behavior: field work and lectures demonstrate applications, particularly in outdoor recreation. Spring. Mr. Morrison.

710. Advanced Principles of Forestry Economics I (3)
Two hours of lecture, two hours of discussion. Intensive study of the microeconomics of forestry. Offered only to graduate students. Fall. Staff.

711. Advanced Principles of Forestry Economics II (3)
Two hours of lecture, two hours of discussion. Intensive study of the macroeconomics of forestry. Offered only to graduate students. Spring. Staff.

732. Research Methods (3)
Instruction regarding methodology in the approach to and solution of problems in Forest Management research. Restricted to graduate students in Forest Management. Spring. Staff.

751. World Forestry (3)
Three hours of lecture and discussion. World forest distribution and types; regional production and consumption of forest products; international trade in timber and related products; the role of forest resources in development; and special topics; tropical forestry, comparative forest policies and programs, forestry education, the problems of developing countries, international cooperation in forestry development, the role of the United States in world forestry, etc. Fall or Spring. Staff.
Prerequisite: Graduate status.

752. Applied Forest Management (3)
Principles and practices of forest management as applied to specific forest properties under the guidance of responsible public and private foresters. Several days are spent in the field studying forest conditions, organizations, operations, and problems. By observing actual forest operations, students become acquainted with the latest and most efficient forest practices in office and forest. Fall. Mr. Horn.

753. Resources Policy **(3)**
Three hours of lecture and seminar. Evaluation of basic environmental and resource issues and their evolvement in public and institutional policies. Exploration of alternative resource goals, policies, and program approaches and their implications. Analysis of processes for policy delineation and modification. Fall. Mr. P. F. Graves.

754. Advanced Forest Administration **(3)**
Critical appraisal of existing public, semi-public and private forestry agencies in the United States, and the comparative study of major administrative organizations and practices. Occasional inspection trips to forestry headquarters and field units and discussion of internal administrative problems with forest officers. Spring.
Prerequisite: ERM 460 or equivalent.

756. Management Concepts in Planning Forest Production **(3)**
Three hours of lecture and discussion. The theories and principles involved in planning the annual allowable cut and the resulting yearly cutting schedules. The influence of technical decision and socioeconomic pressures upon the level of cutting and the effect of the level of cutting upon the dependent industry. Fall or Spring. Mr. Koten.
Prerequisite: ERM 476 or equivalent.

797. Seminar **(1)**
Group discussion and individual conference concerning current topics, trends and research in management. Fall and Spring. Staff.

798. Research Problems in Resources Management and Policy
(Credit hours arranged according to nature of problem)
Special investigation and analysis of resources management problems where integrative relationships of several subject aspects of forestry are a major consideration. Fall and Spring. Staff.

800. History of Economic Thought in Forestry **(3)**
Three hours of discussion or conference. Systematic study and critique of the development of the thinking of foresters and economists with respect to some segment of the subject matter of forestry economics. Review of major individual contributions to thought and the influence of leading scholars upon the thinking of others. Appraisal of the leading schools of thought. Offered only to graduate students. Fall or Spring. Mr. Bennett.

840. Professional Workshop in Forestry Economics **(3)**
Two hours of seminar and one three-hour laboratory each week. RMP 840 is an internship-workshop in the interpretation of forest economics. The seminars are devoted to problems of programming, materials, instruction, testing, and evaluation. The laboratory incorporates leading a one-hour discussion group in ERM 206 with preparation for that discussion group and with the writing of a report on the laboratory to be used in a subsequent seminar meeting. Fall. Mr. Bennett.
Prerequisites: Econ 605, Econ 606, or permission of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

SCHOOL OF CONTINUING EDUCATION (SCE)

530. (FEN) Pest Identification, Biology and Management **(3)**
A study of the life history and management practices for pests common to the home, landscape and recreational areas. Suggested for pest control personnel and teachers of primary and secondary science areas. Not open to College of Environmental Science and Forestry students. Summer.
Prerequisite: One course in biology.

SILVICULTURE (SIL)

553. Energy Exchange at the Earth's Surface **(3)**
Two hours of lecture and three hours of laboratory. A comprehensive study of the physical processes taking place in the lowest layer of the atmosphere. Primary emphasis on the turbulent transfer of heat, momentum and water vapor and the expression of these fluxes in the microclimate. Spring. Mr. Herrington.
Prerequisite: ERM 452, physics, and calculus.

625. Productivity of Forest Stands **(3)**
Examination of forest tree and stand production variables as related to silvicultural manipulation. Analysis of stand response, such as rate of growth, stem form, product quality, tree quality and value. Preparation of stand treatment schedules. Spring. Mr. Richards and Mr. Johnson.
Prerequisite: Permission of instructor.

632. Soil Genesis, Morphology and Classification **(3)**
Three hours of lecture and/or discussion. A comprehensive study of the soil developmental processes and the resulting morphology. Emphasis is placed on the classification of soils. Some details on soil survey and mapping are included. Spring. Even years. Mr. Craul.
Prerequisites: An introductory soils course or permission of the instructor.

640. Advanced Wildland Hydrology **(3)**
Lecture, discussion and laboratory sessions in advanced problems of forest and range hydrology, watershed management methods and techniques and evaluation of new methods of hydrologic data collection and analysis. Fall. Mr. Black.
Prerequisites: ERM 440 or FEG 340.

641. Watershed Analysis **(3)**
One hour of lecture and six hours of laboratory each week. Lecture and field experience in watershed characterization, inventory, and analysis in terms of land management problems. Fall. Mr. Black.
Prerequisites: ERM 440 and permission of instructor.

642. Snow Hydrology **(3)**
Three one-hour lectures per week and two three-day field trips. Physical characteristics of snow and the energy relations important in its accumulation and dissipation. Problems of measurement and prediction of runoff and melt. Potentials for management. Spring. Mr. Eschner.
Prerequisite: ERM 440 or FEG 340.

677. Advanced Forest Tree Improvement **(3)**
Two hours of lecture and discussion, three hours of laboratory. A study of advanced principles and techniques for genetic improvement of forest trees. Special emphasis is placed on selection and breeding for growth rates, wood quality and insect and disease resistance. Problems of tree hybridization, racial variations, sexual reproduction, and quantitative genetics in forest trees. Laboratory training in cytology and cytogenetics, pollen germination, vegetative propagation and other problems. Independent research problems will be undertaken by the student. Fall or Spring. Mr. Westfall.
Prerequisites: FBL 370 and 371, ERM 455.

730. Research Methods in Silviculture **(3)**
Three hours of lecture or discussion. Research concepts and methodology with particular application to silviculture and its related sciences. More appropriate to beginning students or before taking thesis work. Fall. Staff.
Prerequisite: Permission of instructor.

735. Forest Soil Fertility (Applied Studies) **(2-4)**
Two hours of lecture, one hour of discussion. Up to six hours of laboratory depending on number of credit hours. Influence of soil fertility on development and growth of seedlings and trees, and techniques involved to determine this influence. Chemical and biological analysis to determine levels of soil fertility. Nutrient element deficiencies and their correction by soil amendments and fertilizers. Term projects by the student will be undertaken. Spring. Mr. Leaf.
Prerequisites: CHE 332 and 333, FBO 530, ERM 446, or equivalent.

737. Forest Soil Physics **(4)**
Three hours of lecture and discussion and three hours of laboratory. Presentation of principles of soil physics including water flow, storage and availability, soil permeability, heat transfer, and their consideration as root environmental factors. Analytical procedures are introduced and evaluated. Applications of soil physics to silvics, soil fertility, watershed management and hydrology, soil biology and land-use. Spring. Mr. Craul.
Prerequisites: ERM 345, 446, or their equivalents. Physical chemistry and integral calculus strongly recommended.

777. Quantitative Genetics in Forest Tree Improvement **(3)**
Two-hour lecture and discussion, three hours laboratory. Development of statistical models for determining heritability in forest trees. Breeding models and computer analysis application in forest genetics. Fall or Spring. Mr. Westfall.

797. Graduate Silviculture Seminar **(1)**
Three-hour class discussion per week. Assigned reports and discussion of silvicultural topics. Fall and Spring. Staff.

798. Research Problems in Silviculture
(Credit hours arranged according to nature of problem)
Hours to be arranged. Fall and Spring. Staff.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

WOOD PRODUCTS ENGINEERING (WPE)

596. Special Topics **(1-3)**
Lectures, conferences, discussions and laboratory. Special topics in wood products engineering including techniques in scientific photography, microscopy, laboratory instrumentation, and computer applications as well as other topics of departmental interest. Fall and/or Spring. Staff.
Prerequisite: Consent of instructor.

626. Transport Processes **(3)**
Two hours of lecture and three hours of laboratory. The relationship between wood structure and wood permeability, moisture movement, and heat transfer. Fire retardant and wood-preservation treatments. Wood drying. Unsteady-state transport processes. An

advanced laboratory problem with report in wood-moisture relationships, wood drying, the relationship between wood permeability and treatability, or wood preservative treatments. Spring. Mr. Siau.
Prerequisite: Permission of instructor.

664. Mechanical Properties of Wood **(3)**
Two hours of lecture and three hours of laboratory. The effect of the anatomical and chemical nature of wood on its response to static and dynamic force systems. The theory of elasticity as applied to wood. Fall. Mr. Davidson.
Prerequisite: Permission of instructor.

666. Wood-Water Relationships **(3)**
Two hours of lecture, three hours of laboratory. Consideration of basic wood-water relationships and the drying of lumber and other wood products. Fall. Mr. Skaar.
Prerequisites: Physics, calculus, WPE 326 or equivalent.

675. Applied Electron Microscopy **(3)**
Two hours of lecture and/or demonstration, three hours of laboratory. The theory and operation of the transmission electron microscope including specimen preparation, photographic technique and interpretation of micrographs. Fall. Mr. Côté.
Prerequisite: None. Consultation with instructor advised.

680. The Anatomy and Ultrastructure of Wood **(2)**
Two hours of lecture and/or demonstration and discussion. The gross, microscopic and submicroscopic structure of wood including organization of the cell wall, distribution of chemical constituents and abnormalities in wood. Fall. Mr. Côté and Mr. de Zeeuw.
Prerequisite: None.

688. Tropical Timbers in Commerce **(2)**
Two hours of lecture. Introduction to the commercial use of tropical timbers; the factors of forest conditions, stand types and wood qualities influencing their utilization and the development of trade. Sources of information. Spring. Mr. de Zeeuw.
Prerequisite: Permission of instructor.

689. Tropical Wood Anatomy **(1)**
Anatomical characters, identification and taxonomy of tropical woods important in commerce. Mr. de Zeeuw.
Prerequisite: WPE 386 or 387. Recommended that WPE 688 be taken concurrently or previously.

796. Advanced Topics **(2-3)**
Lectures, conferences, discussions, and laboratory. Advanced topics in wood products engineering including techniques in scanning and transmission electron microscopy, laboratory instrumentation, and computer applications as well as other topics of departmental interest. Fall and/or Spring. Staff.
Prerequisite: Consent of instructor.

797. Wood Products Engineering Seminar **(2-3)**
Conference, discussion and reports analyzing current research and new developments, new literature and subject matter surveys in wood products engineering. Fall and Spring. Staff.

798. Research in Wood Products Engineering
(Credit hours arranged according to nature of problem)
Investigations on directed study in wood products engineering including manufacturing, marketing, anatomy, physics, quality, and mechanical properties of wood. One typewritten report (original and one carbon) required. Fall and Spring. Staff.

880. Interpretation of Cellular Ultrastructure **(2)**

One hour of lecture, two hours of demonstration and discussion. The organization and sculpturing of the walls of plant cells; the cellulose microfibril, matrix and incrusting substances, and the warty layer. The ultrastructure and general function of cytoplasmic organelles in cells. The tools and techniques used for light and electron microscopic study of cells, and the interpretation of structural evidence. Directed study and discussion of the latest (current) literature on pertinent topics. Spring. Mr. Côté.

Prerequisite: Permission of the instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**

Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**

Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

State University of New York

The State University of New York, now in its 28th year of service, is the largest, centrally managed, multi-level system of public higher education in the nation.

Since its founding in 1948, through consolidation of 29 State-supported but unaffiliated campuses, the University has grown in response to need until its services are now felt educationally, physically and culturally, the length and breadth of New York State.

The University's 64 geographically dispersed campuses bring educational opportunity within commuting distance of virtually all New York citizens. In many communities, the SUNY campuses are cultural centers of the area and a significant contributor to the local economy.

In academic 1975-76, nearly 355,000 students are studying in its classrooms or pursuing study at home, at their own pace, through such innovative institutions as Empire State College, a campus without walls. More than 100,000 students are 24 years of age or older, reflecting SUNY's ability to adjust to meet the needs of more mature students.

During its relatively brief existence, it has graduated more than 600,000 alumni, the majority of whom are pursuing their careers in villages, towns and cities across the State.

Chancellor Ernest L. Boyer, in a recent report to the University's Trustees, emphasized the diverse role of SUNY when he said:

"The State University welcomes not only the future architects, business executives, engineers, surgeons and literary critics, but also future dairy farmers and medical technicians, accountants and social workers, foresters and automobile mechanics. And through work in film, electronics, pollution control, data processing, police science, urban studies and similar fields, the University seeks to educate persons for tomorrow's roles as well as those of today."

To provide such opportunity on a continuing basis, the University is uniquely organized into a system comprised of:

Four University centers (two of which, Buffalo and Stony Brook, include health science centers); two medical centers; 13 colleges of arts and science, a non-residential college; three specialized colleges, six agricultural and technical colleges; five statutory colleges administered in cooperation with Cornell and Alfred Universities; and 30 locally-sponsored community colleges.

In addition to baccalaureate studies, 12 of the senior campuses offer graduate study at the doctoral level, and 22 at the master's level.

The two-year colleges offer associate degree opportunities in arts and science in a wide range of technical areas. They also provide transfer programs within the University for students wishing to continue to the baccalaureate degree.

Ten Educational Opportunity Centers serve the educationally deprived by upgrading occupational skills for more gainful employment and identifying students with college potential to prepare them for enrollment in the State's public and private colleges.

Overall, at its EOC's, two-year colleges, four-year campuses and university and medical centers, the University offers 3,500 academic programs.

State University is governed by a Board of Trustees, appointed by the Governor, which determines the policies to be followed by the 34 State-supported campuses.

The 30 community colleges operating under the program of State University have their own local board of trustees. The State contributes one-third to 40 percent of their operating costs and one-half of their capital costs.

The State University motto is "Let Each Become All He Is Capable of Being."

STATE UNIVERSITY OF NEW YORK

Office of the Chancellor, 99 Washington Avenue, Albany, New York 12210

UNIVERSITY CENTERS

State University at Albany
State University at Binghamton
State University at Buffalo
State University at Stony Brook

MEDICAL CENTERS

Downstate Medical Center at Brooklyn
Upstate Medical Center at Syracuse

COLLEGES OF ARTS AND SCIENCE

College at Brockport
College at Buffalo
College at Cortland
Empire State College
College at Fredonia
College at Geneseo
College at New Paltz
College at Old Westbury
College at Oneonta
College at Oswego
College at Plattsburgh
College at Potsdam
College at Purchase
College at Utica/Rome

SPECIALIZED COLLEGES

College of Environmental Science and Forestry at Syracuse
Maritime College at Fort Schuyler (Bronx)
College of Optometry at New York City

AGRICULTURAL AND TECHNICAL COLLEGES (Two-Year)

Alfred
Canton
Cobleskill
Delhi
Farmingdale
Morrisville

STATUTORY COLLEGES

College of Ceramics at Alfred University
College of Agriculture and Life Sciences at Cornell University
College of Human Ecology at Cornell University
College of Veterinary Science at Cornell University
School of Industrial and Labor Relations at Cornell University

COMMUNITY COLLEGES

(Locally-sponsored two-year colleges under the program of State University)

Adirondack Community College at Glens Falls
Broome Community College at Binghamton
Cayuga County Community College at Auburn
Clinton Community College at Plattsburgh
Columbia-Greene Community College at Hudson
Community College of the Finger Lakes at Canandaigua
Corning Community College at Corning
Dutchess Community College at Poughkeepsie
Erie Community College at Buffalo
Fashion Institute of Technology at New York City
Fulton-Montgomery Community College at Johnstown
Genesee Community College at Batavia
Herkimer County Community College at Herkimer
Hudson Valley Community College at Troy
Jamestown Community College at Jamestown
Jefferson Community College at Watertown
Mohawk Valley Community College at Utica
Monroe Community College at Rochester
Nassau Community College at Garden City
Niagara County Community College at Sanborn
North Country Community College at Saranac Lake
Onondaga Community College at Syracuse
Orange County Community College at Middletown
Rockland Community College at Suffern
Schenectady County Community College at Schenectady
Suffolk County Community College at Selden
Sullivan County Community College at Loch Sheldrake
Tompkins-Cortland Community College at Dryden
Ulster County Community College at Stone Ridge
Westchester Community College at Valhalla

College of Environmental Science and Forestry

COLLEGE ADMINISTRATION

President	EDWARD E. PALMER
Assistant to the President	C. PETER CLUTE
Assistant to the President for Community Relations	ROLLA W. COCHRAN
Vice President for Program Affairs	RICHARD E. PENTONEY
Assistant Vice President for Research Programs	DONALD F. BEHREND
Assistant Vice President for Academic Programs	WILLIAM E. GRAVES
Executive Director, Institute of Environmental Program Affairs	DONALD F. BEHREND
Coordinator of Sponsored Programs	J. DONALD MABIE
Vice President for Student Affairs	HARRISON H. PAYNE
Director of Admissions	ROBERT L. FRIEDMAN
Financial Aids Coordinator	JOHN R. REEVES
Registrar	DONALD F. GREEN
Director of Student Counseling	ALAN D. FINNEGAN
Coordinator of Career Services	WILLIAM F. SHELDON
Adjunct Foreign Student Counselor	VIRGINIA T. TORELLI
Vice President for Administration and Services	DAVID G. ANDERSON
Director of Business and Fiscal Affairs	HARRY J. CORR
Librarian	DONALD F. WEBSTER
Coordinator of Educational Communications	DAVID L. HANSELMAN
Director of Computer Services	CHARLES N. LEE
Director of Personnel (Acting)	STEPHEN H. MONTGOMERY
Director of Physical Plant	THEODORE J. KOCHANEK
Coordinator of Facilities	CHARLES N. LaFORTY
Director of Campus Safety and Security	JOHN F. LITCHER
Associate for Institutional Research	RHONDDA K. CASSETTA
Director of Analytical and Technical Services	JOHN A. MEYER
Affirmative Action Officer	ALTON W. ZANDERS
Dean, School of Biology, Chemistry and Ecology	STUART W. TANENBAUM
Dean, School of Continuing Education	JOHN M. YAVORSKY
Dean, School of Environmental and Resource Engineering	ROBERT V. JELINEK
Dean, School of Environmental and Resource Management	CHARLES C. LARSON
Dean, School of Landscape Architecture	BRADFORD G. SEARS
Director, School of Forest Technology	DANIEL M. CASTAGNOZZI
Director, Graduate Program in Environmental Science	ROBERT D. HENNIGAN
Director, Adirondack Ecological Center	WILLIAM C. TIERSON
Director, Applied Forestry Research Institute	RAYMOND L. MARLER
Director, Empire State Paper Research Institute	BENGT LEOPOLD
Director, State University Polymer Research Center	MICHAEL M. SZWARC
Director, Ultrastructure Studies Center	WILFRED A. CÔTÉ, JR.
Director, Tropical Timber Information Center	ROBERT W. DAVIDSON
Director, Cellulose Research Institute	TORE E. TIMELL
Project Leader, U.S. Forest Service Cooperative Research Unit	J. ALAN WAGAR

COLLEGE FACULTY AND PROFESSIONAL STAFF

This listing represents an official record of the State University of New York College of Environmental Science and Forestry faculty and professional staff for 1976. It is designed for use in 1976-77. Any changes should be filed with the Office of Personnel.

The date in parentheses after each name denotes the first year of service, two or more dates, the term of service. An asterisk (*) indicates graduate faculty.

MAURICE M. ALEXANDER (1949)*, *Professor and Chairman*, Department of Forest Zoology; B.S., State University of New York College of Forestry, 1940; M.S., University of Connecticut, 1942; Ph.D., State University of New York College of Forestry, 1950

DOUGLAS C. ALLEN (1968)*, *Associate Professor*, Department of Forest Entomology; B.S., University of Maine, 1962; M.S., 1965; Ph.D., University of Michigan, 1968

IRA H. AMES (1972), *Adjunct Assistant Professor*, Department of Botany and Pathology; B.A., Brooklyn College, 1959; M.S., New York University, 1962; Ph.D., 1966

THOMAS E. AMIDON, (1975), *Instructor*, Department of Paper Science and Engineering; B.S., College of Environmental Science and Forestry, 1968; M.S., 1974; Ph.D., 1975

DAVID G. ANDERSON (1959), *Vice President for Administration and Services; Associate Professor*; A.A.S., State University of New York College of Forestry (Ranger School), 1950; B.S., State University of New York College of Forestry, 1953; M.S., University of Utah, 1958

ROBERT E. ANTHONY (1953), *Technical Specialist*, Department of Botany and Pathology; A.A.S., State University of New York Agricultural and Technical College at Morrisville, 1952

GEORGE R. ARMSTRONG (1950)*, *Professor*, Department of Managerial Science and Policy; B.S., State University of New York College of Forestry, 1949; M.S., 1959; Ph.D., 1965

ROBERT W. ARSENEAU (1972), *Programmer/Analyst*, Computer Center; A.A.S., Mohawk Valley Community College, 1967

DEBORAH A. AUGER (1975), *Intern*, Office of Academic Programs; B.A., University of Rhode Island, 1971

JAMES P. BAMBACHT (1967)*, *Assistant Professor*, Department of Paper Science and Engineering; A. B., Kalamazoo College, 1954; M.S., The Institute of Paper Chemistry, 1956; Ph.D., State University of New York College of Environmental Science and Forestry, 1973

C. ELLISON BECK (1970), *Technical Specialist*, Analytical and Technical Services, Office of the Vice President for Administration and Services

DONALD F. BEHREND (1960-67) (1968)*, *Assistant Vice President for Research Programs; Executive Director of the Institute of Environmental Program Affairs; Senior Research Associate*; B.S., University of Connecticut, 1958; M.S., 1960; Ph.D., State University of New York College of Forestry, 1966

ROBERT M. L. BELLANDI (1974), *Research Assistant*, Institute of Environmental Program Affairs; B.S., Montana State University, 1972; M.R.P., Syracuse University, 1973

LEE U. BENDER (1970)*, *Associate Professor*, Department of Forest Engineering; State University of New York College of Forestry (Ranger School), 1953; B.S., State University of New York College of Forestry, 1959; M.S., 1960; Ph.D., Ohio State University, 1971

DAVID J. BENNETT (1973), *Research Assistant*, Empire State Paper Research Institute; B.S., State University of New York College of Forestry, 1968; M.S., Syracuse University, 1971

JOHN D. BENNETT (1960)*, *Associate Professor*, Department of Managerial Science and Policy; B.A., Ohio Wesleyan University, 1954; Ph.D., Syracuse University, 1968; *Chancellor's Award for Excellence in Teaching* (1973)

CAMILLO BENZO, (1975), *Adjunct Associate Professor*, Department of Forest Zoology; B.A., Utica College of Syracuse University, 1964; Ph.D., University of Pennsylvania, 1969

JOHN V. BERGLUND (1965)*, *Associate Professor*, Department of Silviculture and Forest Influences; B.S. Pennsylvania State University, 1962; M.S., 1964; Ph.D., State University of New York College of Forestry, 1968

WILLIAM H. BETTINGER (1972), *Technical Specialist*, Analytical and Technical Services, Office of the Vice President for Administration and Services

DONALD H. BICKELHAUPT (1969), *Technical Assistant*, Department of Silviculture and Forest Influences; B.S., State University of New York College of Forestry, 1969

PETER E. BLACK (1965)*, *Professor*, Department of Silviculture and Forest Influences; B.S., University of Michigan, 1956; M.F., 1958; Ph.D., Colorado State University, 1961; *Executive Chairman of the Faculty* (1974-76)

J. T. C. BOHM, (1974), *Visiting Scientist*, Empire State Paper Research Institute; Ph.D., Agricultural University, Wageningen, The Netherlands, 1974

WILLIAM R. BORGSTEDE (1971), *Technical Assistant*, Department of Forest Zoology; A.A.S., Miner Institute, 1966; A.A.S., State University of New York College at Delhi, 1970; B.S., State University of New York College of Environmental Science and Forestry, 1975

JEROME BREZNER (1961)*, *Professor*, Department of Forest Entomology; A.B., University of Rochester, 1952; A.M., University of Missouri, 1956; Ph.D., 1959

KENNETH W. BRITT (1969), *Paper Research Consultant*, Empire State Paper Research Institute; B.S., Cornell University, 1929

ROBERT H. BROCK, JR. (1967)*, *Professor*, Department of Forest Engineering; B.S., State University of New York College of Forestry, 1958; M.S., 1959; Ph.D., Cornell University, 1971

RANIER H. BROCKE (1969)*, *Senior Research Associate*, Adirondack Ecological Center; B.S., Michigan State University, 1955; M.S., 1957; Ph.D., 1970

ALTON F. BROWN (1963), *Research Assistant*, Empire State Paper Research Institute

KENNETH F. BURNS (1970), *Technical Assistant*, Applied Forestry Research Institute; A.A.S., Paul Smith's College, 1969

HARRY W. BURRY (1962), *Associate Public Service Officer*, Applied Forestry Research Institute; *Associate Professor*; B.S., State University of New York College of Forestry, 1941; M.F., 1964

PAUL M. CALUWE (1969)*, *Senior Research Associate*, Department of Chemistry; M.S., University of Louvain, 1964; Ph.D., 1967

ROBERT CAMERON (1974), *Research Assistant*, Adirondack Ecological Center; State University of New York College of Environmental Science and Forestry (Ranger School), 1973

ROBERT W. CAMPBELL (1972)*, *Adjunct Associate Professor*, Department of Entomology; B.S., State University of New York College of Forestry, 1953; M.F., University of Michigan, 1959; Ph.D., 1961

WILBUR H. CAMPBELL (1975), *Assistant Professor*, Department of Chemistry; A.A., Santa Ana College, 1965; B.A., Pomona College, 1967; Ph.D., University of Wisconsin, 1972

HUGH O. CANHAM (1966)*, *Assistant Professor*, Department of Managerial Science and Policy; B.S., State University of New York College of Forestry, 1960; M.S., 1962; Ph.D., 1971

JOANNE CAPONE, (1975), *Intern*, Office of Research Programs, Institute of Environmental Program Affairs; B.A., Rosary Hill, 1972

DIANNE M. CAPRITTA (1967), *Associate Librarian*, F. Franklin Moon Library; B.S., University of Illinois, 1965; M.S.L.S., Syracuse University, 1967

RHONDDA K. CASSETTA (1967), *Associate for Institutional Research*, Office of the Vice President for Administration and Services; A.B., Elmira College, 1933

DANIEL M. CASTAGNOZZI (1956), *Professor and Director*, School of Forest Technology; State University of New York College of Forestry (Ranger School), 1950; B.S.F., University of Michigan, 1952; M.F., State University of New York College of Forestry, 1957

ROBERT E. CHAMBERS (1967)*, *Associate Professor*, Department of Forest Zoology; B.S., Pennsylvania State University, 1954; M.S., 1956; Ph.D., Ohio State University, 1972

WALLACE CHRISTENSEN, (1975), *Adjunct Professor*, Department of Managerial Science and Policy; State University of New York College of Forestry (Ranger School), 1946; B.S.F., University of Michigan, 1949; M.F., State University of New York College of Forestry, 1954; Ph.D., 1957

WILLIAM M. CHRISTIAN (1974), *Technical Assistant*, Department of Security and Safety

NEILS B. CHRISTIANSEN (1960)*, *Associate Professor*, Department of Managerial Science and Policy; *Summer Camp Coordinator*, Warrensburg Campus; B.S. University of Idaho, 1957; M.S., State University of New York College of Forestry, 1959; Ph.D., 1966

C. PETER CLUTE (1969), *Assistant to the President*, Office of the President; B.A., University of Toronto (York University), 1965; M.R.P., Syracuse University, 1975

ROLLA W. COCHRAN (1964), *Assistant to the President for Community Relations*; Office of the President; *Associate Professor*; B.A., Denison University, 1949; M.S., Ohio State University, 1951

JACK B. CODY (1968), *Senior Research Associate*, Applied Forestry Research Institute; B.S., University of Michigan, 1954; M.F., 1963

JAMES M. COLMAN (1973), *Assistant Director of Admissions*, Office of the Vice President for Student Affairs; B.A., Villanova University, 1967; M.A., Lateran University, 1968

HARRY J. CORR (1967), *Director of Business and Fiscal Affairs*, Office of the Vice President for Administration and Services; B.S. Siena College, 1957

WILFRED A. CÔTÉ, JR. (1950)*, *Professor*, Department of Wood Products Engineering; *Director*, Nelson Cortlandt Brown Laboratory for Ultrastructure Studies; B.S., University of Maine, 1949; M.F., Duke University, 1950; Ph.D., State University of New York College of Forestry, 1958

JAMES E. COUFAL (1965), *Associate Professor*, School of Forest Technology; State University of New York College of Forestry (Ranger School), 1957; B.S. State University of New York College of Forestry, 1960; M.S., 1962

PHILLIP J. CRAUL (1968)*, *Associate Professor*, Department of Silviculture and Forest Influences; B.S.F., Pennsylvania State University, 1954; M.S., 1960; Ph.D., 1964

JAMES O. CREVELLING (1970), *Technical Assistant*, Department of Forest Zoology; A.A.S., Paul Smith's College, 1965; M.S., University of Massachusetts, 1967

CLAY M. CROSBY (1964), *Research Assistant*, Empire State Paper Research Institute; B.S., State University of New York College of Forestry, 1964; M.S., 1970

TIBERIUS CUNIA (1968)*, *Professor*, Department of Managerial Science and Policy; Forest Engineer, Ecole Nat. des Eaux et Forets, 1951; M.S., McGill University, 1957

GEORGE W. CURRY (1966)*, *Associate Professor*, School of Landscape Architecture; B.A., Michigan State University, 1962; B.S., 1965; M.L.A., University of Illinois, 1969

BENJAMIN V. DALL (1975)*, *Professor and Chairman*, Department of Managerial Science and Policy; B.S., Yale University, 1955; M.F., 1956; J.D., University of Virginia, 1959; Ph.D., Pennsylvania State University, 1972

JOHN A. D'AMBROSIO (1975), *Director of Development*, Alumni/Development Office; B.A. Hobart College, 1973; M.S., State University of New York at Albany, 1975

ROBERT W. DAVIDSON (1957)*, *Professor and Chairman*, Department of Wood Products Engineering; *Director*, Tropical Timber Information Center; B.S., Montana State University, 1948; M.S., State University of New York College of Forestry, 1956; Ph.D., 1960

ARNOLD C. DAY (1969), *Technical Specialist*, Nelson Cortlandt Brown Laboratory for Ultrastructure Studies

SALVACION De La PAZ (1973), *Assistant Librarian*, F. Franklin Moon Library; B.S.L.S., University of the Philippines, 1956; M.S.L.S., Simmons College, 1962

CARLTON W. DENCE (1951)*, *Senior Research Associate*, Empire State Paper Research Institute; *Professor*, B.S., Syracuse University, 1947; M.S., State University of New York College of Forestry, 1949; Ph.D., 1959

CARL H. De ZEEUW (1946)*, *Professor*, Department of Wood Products Engineering; A.B., Michigan State College, 1934; B.S., 1937; M.S., State University of New York College of Forestry, 1939; Ph.D., 1949

DANIEL L. DINDAL (1966)*, *Professor*, Department of Forest Zoology; B.S., Ohio State University, 1958; M.A., 1961; Ph.D., 1966; *Chancellor's Award for Excellence in Teaching* (1974)

WILLIAM A. DUERR (1952)*, *Adjunct Professor*, Department of Managerial Science and Policy; B.S., Iowa State College, 1934; M.S., University of Minnesota, 1939; A.M., Harvard University, 1941; Ph.D., 1944

GEORGE F. EARLE (1952)*, *Professor*, School of Landscape Architecture; B.F.A., Syracuse University, 1937; M.F.A., Yale University, 1946

HERBERT E. ECHELBERGER (1966), *Research Forester*, U.S. Forest Service Cooperative Recreation and Related Environmental Studies Research Unit; *Adjunct Assistant Professor*; B.S., Southern Illinois University, 1965; M.S., 1966

ANDREW L. EGGERS (1967), *Media Engineer*, Educational Communications Section, Office of The Vice President for Administration and Services

ELIZABETH A. ELKINS (1973), *Assistant Librarian*, F. Franklin Moon Library; B.A., Hartwick College, 1968; M.L.S., State University of New York at Geneseo, 1970

JOHN H. ENGELKEN (1959), *Assistant Professor; Forest Property Manager*, Tully Campus; B.S.F., Utah State University, 1950

ARTHUR R. ESCHNER (1961)*, *Professor*, Department of Silviculture and Forest Influences; B.S., State University of New York College of Forestry, 1950; M.S., Iowa State College, 1952; Ph.D., State University of New York College of Forestry, 1965

ERO A. I. ESKELINEN (1975) *Visiting Scientist*, Empire State Paper Research Institute; M.S., University of Technology, Helsinki, Finland, 1969

EDMUND FALLON (1975), *Adjunct Professor*, Graduate Program in Environmental Science; B.S., Clarkson College of Technology, 1931

JOHN P. FELLEMAN (1973)*, *Assistant Professor*, School of Landscape Architecture; B.C.E., Cornell University, 1966; M.E.C., 1966; D.P.A., New York University, 1975

ALAN D. FINNEGAN (1968), *Director of Student Counseling*, Office of the Vice President for Student Affairs; B.S., St. Lawrence University, 1955; M.Ed., 1959

JEAN E. FISHER (1963), *Senior Research Associate*, Applied Forestry Research Institute; *Professor*; B.S., University of Idaho, 1941

JOHN S. FISHLOCK (1965), *Technical Assistant*, Department of Botany and Pathology; State University of New York College of Forestry, 1965

MICHAEL FLASHNER (1973), *Assistant Professor*, Department of Chemistry; B.S., Brooklyn College, 1965; A.M., University of Michigan, 1970; Ph.D., 1971

CLAUDE C. FREEMAN (1959), *Associate Professor*, School of Landscape Architecture; B.S., State University of New York College of Forestry, 1959

ROBERT L. FRIEDMAN (1967), *Director of Admissions*, Office of the Vice President for Student Affairs; A.B., Syracuse University, 1952; M.A., 1954

EVA GALSON (1965), *Research Assistant*, Department of Chemistry; B.S., Queens College, 1949; M.S., Syracuse University, 1965

THOMAS L. GEE (1975), *Technical Assistant*, Department of Chemistry; A.A., Corning Community College, 1965; B.S., State University of New York at Geneseo, 1968

JAMES W. GEIS (1968)*, *Associate Professor*, Department of Botany and Pathology; B.S.F., University of Illinois, 1965; M.S., 1967; Ph.D., State University of New York College of Environmental Science and Forestry, 1972

SERGE N. GORBATSEVICH (1956)*, *Associate Professor*, Department of Paper Science and Engineering; B.S., State University of New York College of Forestry, 1954; M.S., 1955

MIKLOS A. J. GRATZER (1973)*, *Associate Professor*, Department of Managerial Science and Policy; Diploma for Engineering, Sopron University, 1956; B.Sc., University of British Columbia, 1959; M.S.R.C., University of Montana, 1965; Ph.D., 1971

PAUL F. GRAVES (1947)*, *Professor*, Department of Managerial Science and Policy; B.S., State University of New York College of Forestry, 1939; M.F., 1941; Ph.D., Syracuse University, 1950

WILLIAM E. GRAVES (1967)*, *Assistant Vice President for Academic Programs*, Office of the Vice President for Program Affairs; *Associate Professor*, Department of Forest Zoology; B.S., University of Massachusetts, 1963; M.S., University of Wisconsin, 1965; Ph.D., 1967

RICHARD L. GRAY (1975) *Research Associate*, Applied Forestry Research Institute; B.A. State University of New York College of Environmental Science and Forestry, 1967; M.A., 1970; Ph.D., 1974

DONALD F. GREEN (1965), *College Registrar*, Office of the Vice President for Student Affairs; *Associate Professor*; A.B., New York State College for Teachers, Albany, 1942; M.S., 1950

DAVID H. GRIFFIN (1968)*, *Associate Professor*, Department of Botany and Pathology; B.S., State University of New York College of Forestry, 1959; M.A., University of California, 1960; Ph.D., 1963

DAVID G. GRIMBLE (1968), *Senior Research Associate*, Applied Forestry Research Institute; A.A.S., Paul Smith's College, 1961; B.S. Michigan Technical University, 1964; M.F. University of Michigan, 1966

DAVID M. GUOKAS (1973), *Technical Assistant*, School of Landscape Architecture; B.A., University of Kentucky, 1972

AUSTIN F. HAMER (1968), *Coordinator of Continuing Education*, School of Continuing Education; *Associate Professor*; B.S., Oregon State University, 1942; M.S., University of Oregon, 1962

DAVID L. HANSELMAN (1963)*, *Associate for Educational Communications*, Educational Communications Section, Office of the Vice President for Administration and Services; *Associate Professor*, Department of Managerial Science and Policy; B.S., Cornell University, 1957; M.S., 1958; Ph.D., Ohio State University, 1963

DAVID B. HARPER (1972), *Research Associate*, School of Landscape Architecture; B.S., Bates College, 1959; M.R.P., University of Pennsylvania, 1969

ROY C. HARTENSTEIN (1959-65) (1967)*, *Professor*, Department of Forest Zoology; B.S., State Teachers College at Buffalo, 1953; M.S., Syracuse University, 1957; Ph.D., State University of New York College of Forestry, 1959

GORDON M. HEISLER (1973), *Adjunct Assistant Professor*, Department of Silviculture and Forest Influences; B.S., Pennsylvania State University, 1961; M.F., Yale University, 1962; Ph.D., State University of New York College of Forestry, 1970

ROBERT D. HENNIGAN (1967)*, *Professor*, Department of Managerial Science and Policy; *Director*, Graduate Program in Environmental Science; B.C.E., Manhattan College, 1949; M.A., Syracuse University, 1964

LEE P. HERRINGTON (1965)*, *Professor*, Department of Silviculture and Forest Influences; B.S., University of Maine, 1959; M.F., Yale University, 1960; Ph.D., 1964

JOSEPH A. HIBBARD, (1975), *Visiting Assistant Professor*, Department of Landscape Architecture; B.L.A., College of Environmental Science and Forestry, 1969

BRUCE E. HOLLOWAY (1975), *Technical Assistant*, State University Polymer Research Center; A.S., Hudson Valley Community College, 1970; B.S., College of Environmental Science and Forestry, 1975

BERNARD T. HOLTMAN (1968), *TV/Motion Picture Producer-Director*, Educational Communications Section, Office of the Vice President for Administration and Services; B.A., Siena College, 1950; M.S., Syracuse University, 1972

ALLEN F. HORN, JR. (1957)*, *Professor*, Department of Managerial Science and Policy; B.S., Michigan State University, 1950; M.S., 1951; Ph.D., State University of New York College of Forestry, 1957; L.L.B., Syracuse University, 1967

PAUL R. HUGHES (1972), *Technical Assistant*, Department of Paper Science and Engineering

HUGO A. JAMNBACK (1973), *Adjunct Senior Research Associate*, Department of Forest Entomology; B.A., Boston University, 1949; M.A., University of Massachusetts, 1951; Ph.D., 1953

ROBERT V. JELINEK (1972)*, *Professor and Dean*, School of Environmental and Resource Engineering; B.S., Columbia University, 1945; M.S., 1947; Ph.D., 1953

HAZEL S. JENNISON (1965), *Research Assistant*, Analytical and Technical Services, Office of the Vice President for Administration and Services; B.S., Western Kentucky State College, 1941; M.S., Syracuse University, 1966

DAVID L. JOHNSON (1975), *Assistant Professor*, Department of Chemistry; B.S., Antioch College, 1965; Ph.D., University of Rhode Island, 1973

JOHN W. JOHNSON (1970)*, *Professor and Chairman*, Department of Silviculture and Forest Influences; B.S., University of Michigan, 1946; Ph.D., North Carolina State University, 1972

WILLIAM L. JOHNSON (1974), *Technical Specialist*, Department of Forest Engineering; B.S., University of Wisconsin, 1972; M.S., 1974

RONALD R. KARNS (1965), *Editor*, Office of Publications; B.S., Ohio State University, 1954

ROWENA V. KATHER (1974), *Technical Assistant*, Analytical and Technical Services, Office of the Vice President for Administration and Services

JANET L. KEE (1975), *Research Assistant*, Department of Botany and Pathology; B.S., College of Environmental Science and Forestry, 1973

EDWIN H. KETCHLEDGE (1955)*, *Distinguished Teaching Professor*, Department of Botany and Pathology; *Director*, Cranberry Lake Biological Station; *Forest Manager*, Pack Demonstration Forest, Cranberry Lake Campus; B.S., State University of New York College of Forestry, 1949; M.S., 1950; Ph.D., Stanford University, 1957

THEODORE J. KOCHANEK (1971), *Director of Physical Plant*, Office of the Vice President for Administration and Services

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RUSSELL C. DECKERT (1952-1976), *Professor Emeritus;* B.S.F., University of Georgia, 1938; M.F., Duke University, 1943

JAMES F. DUBUAR (1919-1957), *Director Emeritus, Ranger School; Professor Emeritus;* A.B., University of Michigan, 1913; M.S.F., 1915

C. EUGENE FARNSWORTH (1930-1972), *Professor Emeritus;* B.S.F., Iowa State College, 1926; M.F., Yale University, 1928; Ph.D., University of Michigan, 1945

CARL C. FORSAITH (1917-1959), *Professor Emeritus;* B.A., Dartmouth College, 1913; M.A., Harvard University, 1914; Ph.D., 1917

CLIFFORD H. FOSTER (1927-1959), *Professor Emeritus;* B.S., New York State College of Forestry, 1921; M.F., 1922; M.S., Harvard University, 1924

RUSSELL E. GETTY (1966-1973), *Professor Emeritus;* B.S., Iowa State College, 1936; M.S., 1951

PHILIP J. HADDOCK (1929-1970), *Assistant Professor Emeritus;* New York State College of Forestry (Ranger School), 1926

GEORGE H. HAINES (1953-1968), *Director of Business Affairs Emeritus;* B.S., University of Rhode Island, 1932

WILLIAM M. HARLOW (1928-1965), *Professor Emeritus;* B.S., New York State College of Forestry, 1925; M.S., 1926; Ph.D., 1928

RAY R. HIRT (1921-1959), *Senior Professor Emeritus;* B.S., Hamline University, 1917; M.S., New York State College of Forestry, 1924; Ph.D., 1928

RAYMOND J. HOYLE (1918-1957), *Professor Emeritus;* B.S., New York State College of Forestry, 1917; M.S., Syracuse University, 1930

EDWIN C. JAHN (1938-1972), *Dean Emeritus; Professor Emeritus;* B.S., New York State College of Forestry, 1925; M.S., 1926; Ph.D., McGill University, 1929

RALPH T. KING (1937-1965), *Professor Emeritus;* B.S., Utah State Agricultural College, 1924; M.S., 1925

ORRIN L. LATHAM (1930-1966), *Associate Professor Emeritus;* B.S.F., Iowa State College, 1927; Yale University, 1932

JCSIAH L. LOWE (1933-1975), *Professor Emeritus;* B.S., New York State College of Forestry, 1927; Ph.D., University of Michigan, 1938

AUBREY H. MacANDREWS (1926-1962), *Professor Emeritus;* Truro Agriculture College, 1922; B.S., New york State College of Forestry, 1925; M.S., 1926

HENRY F. A. MEIER (1912-1914) (1929-1946), *Professor Emeritus;* B.A., Indiana University, 1912; M.A., 1913; Ph.D., Columbia University, 1920

JOHN L. MORRISON (1946-1971), *Professor Emeritus;* A.B., University of Nebraska, 1933; A.M., 1935; Ph.D., University of California, 1941

FREDERIC W. O'NEIL (1937-1974), *Professor Emeritus;* B.S., New York State College of Forestry, 1933; M.S., 1935

LUCIAN P. PLUMLEY (1936-1967), *Director Emeritus,* Ranger School; *Professor Emeritus;* New York State College of Forestry (Ranger School), 1931; B.S., New York State College of Forestry, 1935

JOHN C. SAMMI (1929-1967), *Professor Emeritus;* B.S., University of California, 1922; M.F., New York State College of Forestry, 1931

HARDY L. SHIRLEY (1945-1967), *Dean Emeritus; Professor Emeritus;* B.A., Indiana University, 1922; Ph.D., Yale University, 1928; D.h.c., University of Helsinki, 1958; D.Sc., Syracuse University, 1966

BRUCE T. STANTON (1946-1972), *Professor Emeritus;* New York State College of Forestry (Ranger School), 1927; B.S., New York State College of Forestry, 1940; M.F., 1942

LeROY C. STEGEMAN (1929-1965), *Professor Emeritus;* B.S., Michigan State College, 1928; M.S., University of Michigan, 1929

VIVIAN R. SUTTON (1962-1976), *Associate Professor Emeritus;* B.A., Oberlin College, 1934; M.A., Bryn Mawr College, 1937; Ph.D., 1942

RALPH G. UNGER (1937-1964), *Professor Emeritus;* B.S., New York State College of Forestry, 1930

ARTHUR T. VIERTEL (1946-1975), *Associate Professor Emeritus;* B.S., New York State College of Forestry, 1942; Ph.D., 1954

WILLIAM L. WEBB (1937-1975), *Professor Emeritus; Dean Emeritus;* B.S., University of Minnesota, 1935; M.S., 1940; Ph.D., Syracuse University, 1950

FAY WELCH (1932-1967), *Lecturer Emeritus;* B.S., New York State College of Forestry, 1922

WALTER L. WELCH (1950-1965), *Associate Professor Emeritus;* A.B., Syracuse University, 1946

HAROLD G. WILM (1953-1966), *Professor Emeritus; Associate Dean Emeritus;* B.S., Colorado College, 1929; M.F., Cornell University, 1930; Ph.D., 1932

LOUIS E. WISE (1919-1932), *Professor Emeritus;* B.A., Columbia University, 1907; Ph.D., 1911

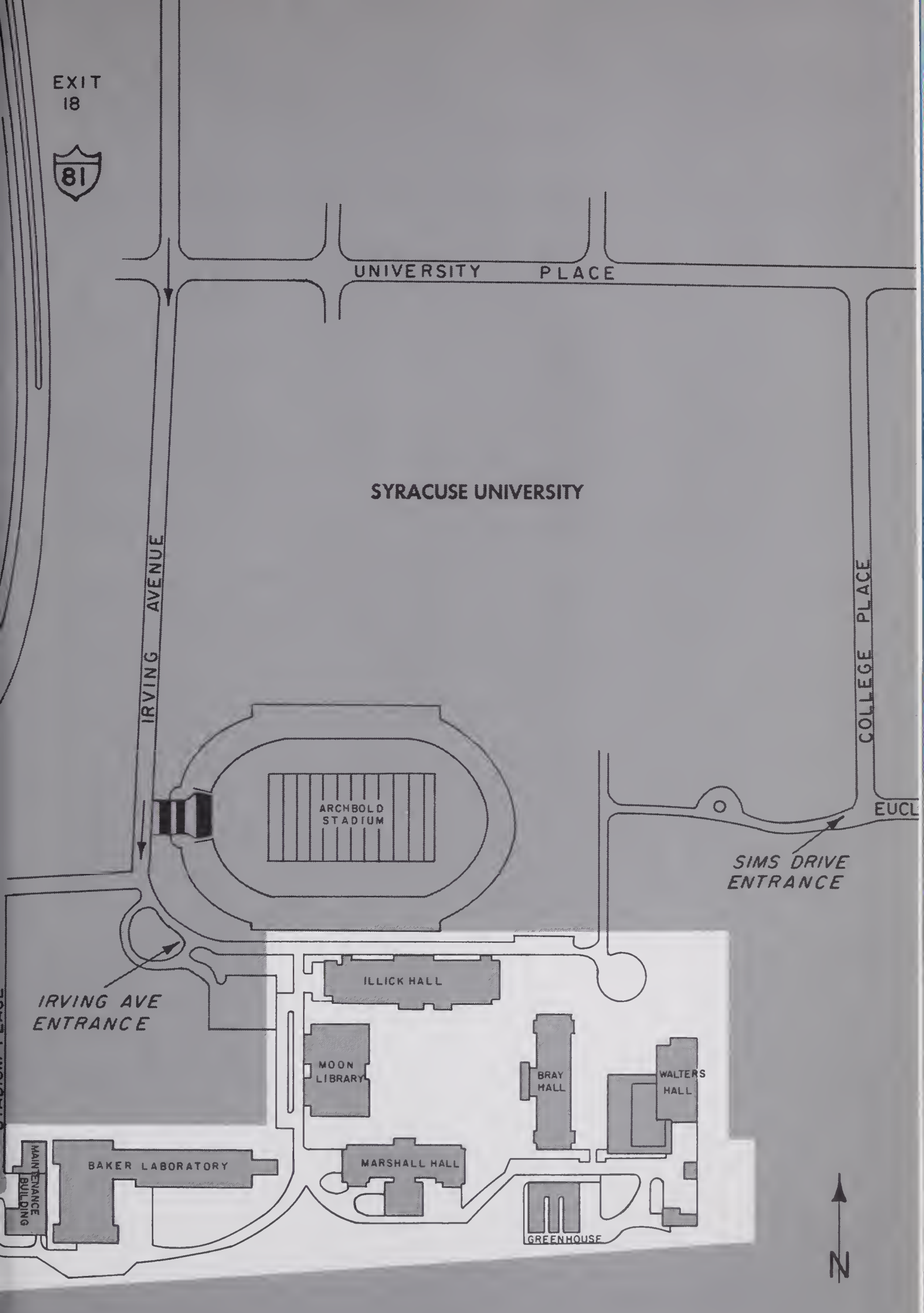
Index

Adirondack Ecological Center 18
Administration, College 92
Admission 27
-Requirements 27
-Advanced Tests 27
-Procedure 27
-International Students 28
AFRI 11
Applied Forestry Research
Institute 11
Assistantships 31
Biology, Chemistry and Ecology,
School of 38
Biology, Forest 62
Board of Trustees
-ESF 91
-SUNY 87
Botany 38, 63
Calendar, Academic 2
Campuses, Regional System of 15
Career Services 32
Chemistry 42, 65
Commencement Fee 29
Computer Center 17
Continuing Education 9, 83
Cooperative Research Unit,
U.S. Forest Service 13
Correspondence Directory
Inside Front Cover
Course Offerings 59
Cranberry Lake Campus 18
Degree Requirements 25
Degrees, Graduate 25
Economics, Forest 50
Educational Communications
Unit 17
Ellis International Laboratory 18
Empire State Paper Research
Institute 12
ESPRI 12
Employment, Part-Time 32
Engineering 43
-Forest Engineering 43, 68
-Paper Science and
Engineering 44
-Wood Products Engineering 45
Entomology 39, 70
Environmental and Resource
Engineering 62
Environmental and Resource
Engineering,
School of 43
Environmental and Resource
Management,
School of 46
Environmental Communications . 51
Environmental Science 35, 61
Expenses, Student 29
Experiment Station 18
Faculty, College 93
Faculty, Emeritus 106
Fellowships 31
Financial Assistance 31
Forest Biology 62
Forest Engineering 43, 68
Forest Entomology 39, 70
Forest Influences 47, 54
Forest Pathology 38, 63

Forest Service, U.S. 13
Forest Soil Science 53
Forest Technology, School of 17
Forest Zoology 40, 72
Genetic Field Station 18
Grants-In-Aid, SUNY 32
Heiberg Memorial Forest 17
History and Traditions, College 5
Housing, Student 29
Huntington Wildlife Forest 18
Institute of Environmental
Program Affairs 11
IEPA 11
Instruction 8
-Continuing Education 9
-Graduate 8, 23
-Professional 8
-Technical 8
International Students 28
Landscape Architecture 55, 74
Landscape Architecture,
School of 55
Land Use Planning 51
Loans, Educational 32
Management 48
Managerial Science and Policy 46
Map and Locator, Campus 110
Mathematics, Applied 60
Mission, College 8
Moon Library, F. Franklin 16
Newcomb Campus 18
Organic Materials Science 36
Pack Demonstration Forest, C.L. . 18
Paper Science and
Engineering 44, 78
Pathology, Forest 38, 63
Policy and Administration 49
Polymer Center, SUNY 12
Professional Staff 93
Public Service 13
Quantitative Methods 50
Recreation Management 49
Research 10
Resource Management and
Policy 48, 79
Silvics 52
Silviculture 47, 53, 83
Soil Science, Forest 53
State University of New York 87
Syracuse Campus, ESF 15
Syracuse Metropolitan Area 21
Syracuse University 6, 35, 59
Tree Improvement 54
Tuition and Fees 29
Tuition Assistance Program 32
Tuition Waiver Scholarships 32
Tully Campus 17
Ultrastructure Studies Laboratory,
N. C. Brown 13
Upstate Medical Center, SUNY ... 59
Wanakena Campus 17
Warrensburg Campus 17
Water Resources 37
Wood Products Engineering ... 45, 84
Work-Study Program 32
World Forestry 54
Zoology, Forest 40, 72

Campus Locator

Admissions Office	110 Bray
Affirmative Action Office	110 Bray
Alumni/Development Office	121 Bray
Analytical and Technical Services	139 Baker
Applied Forestry Research Institute	6 Moon
Assistant Vice President for Academic Programs	200 Bray
Assistant Vice President for Research	217 Bray
Audio-tutorial Center	16 Moon
Business and Fiscal Affairs	102 Bray
Career Services	107 Bray
Cellulose Research Institute	314 Baker
Community Relations Office	123 Bray
Computer Services	323 Baker
Counseling Services	107 Bray
Educational Communications Unit	301 Illick
Empire State College	115 Bray
Empire State Paper Research Institute	317 Walters
Facilities Office	Maintenance Building
Film Library	9 Moon
Financial Aids Office	111 Bray
International Forestry	319 Bray
Institute of Environmental Program Affairs	217 Bray
Institutional Research	206 Bray
Library Office	101 Moon
Maintenance and Operations	Maintenance Building
Personnel Office	224 Bray
President's Office	204 Bray
Publications Office	100 Bray
Registrar	113 Bray
School of Biology, Chemistry and Ecology	311 Baker
School of Continuing Education	231 Baker
School of Environmental and Resource Engineering	208 Walters
School of Environmental and Resource Management	319 Bray
School of Landscape Architecture	331 Marshall
Security and Safety	8 Bray
Student Council Office	18 Moon
SUNY Polymer Research Center	216 Baker
Ultrastructure Studies Center	417 Baker
U.S. Forest Service Cooperative Research Unit	106 Marshall
Veterans' Affairs	104 Bray
Vice President for Administration and Services	208 Bray
Vice President for Program Affairs	227 Bray
Vice President for Student Affairs	107 Bray
Wood Utilization Service	13 Moon



COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

State University of New York
COLLEGE OF ENVIRONMENTAL SCIENCE
AND FORESTRY
Syracuse, New York 13210

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environmental science and forestry

Graduate Studies 1977-78

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200 Bray Hall
473-8631

Transcripts and Academic Records
Registrar
111 Bray Hall
473-8717

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473-8884

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State University of New York

COLLEGE OF

ENVIRONMENTAL SCIENCE AND FORESTRY

1977-78

Graduate Studies Bulletin

TABLE OF CONTENTS

Academic Calendars	2
ESF: What's In A Name?	5
The Mission: Instruction, Research, Public Service	8
The Campuses	15
The Syracuse Metropolitan Area	21
Graduate Study At ESF	23
Requirements For Degrees	25
Admission	27
Expenses	29
Financial Assistance	31
Graduate Degree Programs	35
Course Offerings	61
State University of New York	87
College Trustees And Administration	91
College Faculty And Professional Staff	93
Index	108
Campus Locator And Map	110

Academic Calendar

SYRACUSE CAMPUS

FALL 1977

Registration	September 7-8	Wednesday-Thursday
First Day of Classes	September 9	Friday
Yom Kippur (no classes)	September 22	Thursday
Thanksgiving Vacation	November 23-27	Wednesday-Sunday
Last Day of Classes	December 16	Friday
Exam Period	December 19-23	Monday-Friday

SPRING 1978

Registration	January 16-17	Monday-Tuesday
First Day of Classes	January 18	Wednesday
Spring Recess	March 11-19	Saturday-Sunday
Last Day of Classes	May 2	Tuesday
Reading Day	May 3	Wednesday
Exam Period	May 4-10	Thursday-Wednesday
Commencement	May 13	Saturday

ESF: What's In A Name?

1911. Governor John A. Dix signed a bill establishing the New York State College of Forestry at Syracuse University.

1948. Legislative action incorporated in State University of New York all state-supported higher education. Thus, the State University College of Forestry at Syracuse University.

1972. By special legislative act, the College was renamed the State University of New York College of Environmental Science and Forestry.

Why, in the first place, all the name changes? And, secondly, what difference do they make? What, really, is in our name?

ESTABLISHING A TRADITION

While a professional forestry education in this country is almost entirely a development of the twentieth century, its primary roots can be traced back as early as 1862 when Congress passed the Morrill Act establishing a system of land-grant colleges.

The growing importance of forests in America's economy was reflected in the 1870 Census, when, for the first time, information on forest resources was included. Several attempts to establish a national school of forestry were made; while none was approved, the movement shows that there was considerable demand for professionally trained foresters.

By 1900 there was a spirit of reform in the country—the same spirit that produced the early muckrakers also produced a generation interested in the conservation, preservation and careful management of precious natural resources. Between 1903 and 1914, 21 schools of forestry were established.

The first college of forestry in this country to offer a full, four-year undergraduate program was established in 1898 at Cornell University. Under the leadership of Bernard E. Fernow, students were introduced to critical field experience in their junior and senior years at the college's 30,000-acre forest in the Adirondacks. There, Fernow taught many experimental management practices, including clear-cutting and surface-burning. These techniques have always been controversial, and they aroused criticism by the wealthy summer residents in adjacent areas of the Adirondacks. After only five years of operation, the Cornell College of Forestry was closed in 1903 when the State Legislature, yielding to the influential property owners, ended fiscal support.

The beginnings and early development of the New York State College of Forestry were largely due to James R. Day, Chancellor of Syracuse University, and community leaders who were attuned to the growing national sentiment favoring forest conservation and who sensed the need for a professional school of forestry. The legislative act which created the College instructed that the institution "conduct such special research in State-wide investigations in forestry as will throw light upon and help in the solution of forestry problems. . ." and that it be "the institution for educational work in forestry in the State."

From the very first years of its existence under the first dean, Hugh P. Baker, the College responded to the broad needs of environmental professionalism. While other schools and colleges of forestry became more specialized, the College at Syracuse broadened to include the essentials of environmental science: design, engineering and the life sciences, as well as resource management.

BROADENING THE BASE

With the formation of the State University of New York in 1948, coordination and systematization came to higher education in the state. The University, according to its charter, was to "supplement, not supplant, the great network of private colleges and universities." The College of Forestry which, from its beginning had been state-supported and governed by a Board of Trustees made up of eight members appointed by the Governor and four *ex-officio* members, was recognized as a specialized college within the State University system.

Stemming from Chancellor Day's early sponsorship of the College, Syracuse University and ESF have long been engaged in numerous fruitful devices of institutional cooperation. This relationship is probably the most outstanding example in this country of collaboration between public and private institutions of higher education. Even as a part of State University, the College maintains this unique position. The major character of the relationship stems from the fact that for more than 60 years the College purchased from Syracuse University the major portion of its lower division instruction, thus allowing the College to more fully develop its professional senior division and graduate level instruction.

Other cooperative areas are living centers and dining facilities, athletic programs, the use of the University's infirmary and health counseling services, the bookstore facilities, the University library system and participation in numerous social activities including the elaborate religious, dramatic and cultural benefits of a large university.

ESF TODAY

The third phase in the evolvement of the College's name came in 1972 when it was rechartered as the State University of New York College of Environmental Science and Forestry. Thus, the name reflects more deeply the traditional grounding and concern of forestry in the environment; it illuminates more clearly the capabilities of its program.

The College of Environmental Science and Forestry is continuing to move toward a plan, conceived more than 10 years ago, to achieve complete upper division/graduate status. The number of freshmen is being gradually reduced until the time when all entering students will be juniors. Students wishing to embark upon a career in the environmental

sciences and forestry will enroll for two years at a junior college or four-year institution, studying an ESF prescribed math/science program and transfer to this college as a junior. The move to upper division/graduate college status marks another step in the College's long-standing commitment to educate professionals capable of facing the complex environmental problems of today and of the future.

For over 60 years, the full thrust of the State University of New York College of Environmental Science and Forestry has been focused on the environment on all of its six campuses and in each of its three mission areas—instruction, research and public service. The College has been, and continues to be, devoted to the advancement of environmental science and forestry.

The Mission: Instruction, Research, Public Service

INSTRUCTION

Professional Education

In the Fall of 1976, student enrollment reached 2,349. Of this number, 1,910 were undergraduates and 439 were graduate students. In addition, there were 25 students engaged in postdoctoral work.

At the baccalaureate level, the College offers professional study in seven four-year curricula: *biology; chemistry* (with options in biochemistry and natural products or natural and synthetic polymer chemistry); *forest engineering; paper science and engineering; wood products engineering* (with options in wood science, building construction, production systems engineering or materials marketing); *resource management*; and *landscape architecture.*

Each of these curricula leads to the bachelor of science degree. In the case of landscape architecture, an additional year of study results in a bachelor of landscape architecture degree; and in the forest engineering program, a fifth year leading to a bachelor's degree in civil engineering can be taken at Syracuse University or State University at Buffalo.

Several curricula allow students to minor in environmental studies, applied management, urban forestry, regional planning, world forestry, conservation education and communications, management science and forest resources science.

Graduate Education

The College awarded its first graduate degree in 1913. Today the College offers advanced degrees in 7 major program areas: *environmental and forest biology, chemistry, resource management and policy, silviculture and forest influences, environmental and resource engineering, landscape architecture, environmental science.*

Graduate study leads to the master of science degree, the master of landscape architecture degree, and the doctor of philosophy degree. A postdoctoral study program, closely related to the College's research effort, is also available.

Technical Education

At the paraprofessional level, the College has been training forest technicians since 1912 at its Wanakena Campus in the Adirondack Mountains. It is the oldest Ranger School in the United States.

In 1973, a two-year *forest technology* curriculum replaced the one-year certificate program. Graduates are awarded an associate in applied science degree. In the new curriculum, students take their first year of general education at an accredited junior college. The second year, with its emphasis on practical field training in the relationships between forest technology and managerial needs, is taken at Wanakena with its 2,800 acres of forested land. Graduates of this degree program in practical forestry are prepared for positions as forest rangers; federal, state and private industry forest technicians and forestry aides; company district forest supervisors; timber inventory specialists; timber sales supervisors; forest surveyors and engineering aides; and forest protection technicians.

Continuing Education

The philosophy that education is a lifelong pursuit is an ancient one and was written into the law creating the College. This concept is doubly important to the sciences and professions in this technological age when, with new knowledge bursting in all directions, major environmental problems still remain to be resolved. The informational needs of New York's citizens also are undergoing change. The increasing urban character of our population, the changing pattern of agricultural and forest land ownership and use, the rise in level of education and sophistication in a more efficient society, and the increase in leisure time, travel mobility and need for recreational facilities and pursuits all contribute to a growing need for educational opportunities in environmental science and forestry for adult audiences.

The College has, over the years, succeeded in communicating knowledge on forest resources management, utilization and conservation to a variety of off-campus publics. The entire College faculty has contributed to these programs. To reinforce this commitment, the College established a School of Continuing Education upon which to base expanded educational opportunities at both the undergraduate and graduate course levels.

Conferences, symposia, seminars and short courses on various aspects of forestry and the related sciences are conducted at both the basic and applied levels. Audiences include forest owners, managers and operators; wood engineers and forest industries personnel; academic and scientific groups, conservation and recreation personnel from local and other public and private planning groups and citizen-action committees. Upon request, continuing education programs can be designed to meet specific needs of professional organizations, agencies and industry. Credit or noncredit courses, at campus or off-campus sites, can be arranged.

Expansion of "in-service" training courses, establishment of "environmental learning centers" on College forest properties and production of media materials for public information and education are examples of activities directed toward updating and upgrading professional clients and broadening the public's awareness and appreciation of New York's forest-lands and other natural resources.

For information on specific continuing education projects, inquiries should be sent to Dean, School of Continuing Education.

RESEARCH

The College's commitment to scientific inquiry stretches far back to its second year of existence. In 1912, Dean Hugh P. Baker initiated the first research project of the College by joining forces with the U.S. Forest Service in an industry study designed to show what kinds of firms were using wood in New York State and the species and quantities of lumber they used.

In the 1970's, the College's research program has attracted a worldwide clientele of industrial, governmental, professional and scientific groups, and through liaison with them, the program maintains its vigor and relevancy to the important environmental issues of the decade. Support from this clientele amounts to about $2.9 million a year.

Students and faculty from across the College contribute to the depth and diversity of the research program. Findings from these studies are applied to a host of issues and problems through various demonstrations and information devices. Recent examples include studies of limestone quarry reclamation; the development of polymeric materials for artificial human organs; nonchemical control measures for insect pests, e.g., the gypsy moth; studies of the ecology of Antarctic birds; and new wood pulping processes leading to pollution-free water and air effluents.

The Institute of Environmental Program Affairs

The Institute of Environmental Program Affairs (IEPA), created at the College in 1972, is an umbrella-like structure that coordinates the overall research effort of the College with the efforts of other academic institutions, public agencies and private industries for a concerted attack on compelling and complex environmental problems. IEPA culminates the College's ongoing examination of its appropriate role as a leader in environmental education for the 1970's and beyond in face of urgent appeals for multidisciplinary approaches, for problem-oriented task forces by both faculty and students, and for the greater application of higher education to society's needs. Because it is a process, the Institute preserves the identity of each collaborator: institutions, faculty members and students come together for just as long as necessary to solve a problem, then return to other ongoing areas of interest. Recent projects have included: resource and environmental studies for the St. Lawrence Eastern Ontario Commission, and the Tug Hill and Catskill study commissions; a study of wetlands evaluation systems for the Adirondack Park Agency; development of environmental impact assessment guidelines for the New York State Department of Environmental Conservation; a study of selected environmental impacts of possible nuclear power developments in New York State for the Argonne National Laboratory; and studies of the St. Lawrence River ecosystems and impacts of oil spills and extension of the shipping season for the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service, respectively.

Applied Forestry Research Institute

Much of the research being conducted at universities and institutes, while of value to long-range scientific study and technological progress, is of limited, immediate application for forest practitioners. With this consideration, the Applied Forestry Research Institute (AFRI) was established in 1967 at the College with the cooperation of the New York State Department of Conservation. At the time of its founding, AFRI was charged with the task of carrying out research in the state that can be implemented at once by practicing foresters and forest resource managers.

The need for such research becomes more acute with time: the demands placed on the forest resource are ever increasing, and conservation groups are deeply concerned about the environmental impact of forestry's operations.

Research activities of AFRI include the environmental effects of forest practices, forest harvesting and forest products engineering, hardwood and conifer silviculture, forest pest and disease control, and multiple-use management planning.

Because of its location on ESF's main campus, AFRI has access to the College's extensive research equipment and instruments, including electron microscopes, plant growth chambers, photogrammetric facilities and computer center.

There is close cooperation with the College's highly competent teaching-research faculty who provide the latest information about basic research findings by disciplines as well as supporting technical information and techniques. This liaison allows for the exchange of views between the academician and the field practitioner.

AFRI is supervised by a director, and has a staff of six full-time research associates and two technical assistants.

Empire State Paper Research Institute

The Empire State Paper Research Institute (ESPRI), located on the main campus, is the only world-wide basic research organization in the pulp and paper field. It performs investigations in cooperation with the Empire State Paper Research Association (ESPRA), which is comprised of 62 pulp and paper companies in 11 countries. The Institute was established in 1945 when the members of ESPRA recognized the need for new scientific and technical knowledge and methods, and since then ESPRI has been able to maintain an efficient balance between the practical and theoretical bases of the pulp and paper industry.

Housed in the modern J. Henry Walters Hall with its own pilot paper mill, and staffed by scientists who are internationally recognized for their accomplishments, ESPRI provides a research base for long-range industry development. Its program has widened in scope to cover almost all aspects of pulping and papermaking, including additive retention, oxygen pulping and bleaching, effluent control, sheet drying and printability.

State University Polymer Center

In 1966 the College's polymer research institute was designated as the State University of New York Polymer Research Center in order to stimulate University-wide interest in polymer chemistry.

Scientists at the College have made many original contributions to the field of pure and applied polymer chemistry, including the development of living polymers, the study of anionic polymerization and electron-transfer initiation, and work on the permeation of gases and films through polymeric films.

College faculty members specializing in polymer chemistry have trained several hundred graduates and postdoctoral researchers, many of whom now hold leading positions in universities and industrial and governmental laboratories.

U.S. Forest Service Cooperative Research Unit

The Northeastern Forest Experiment Station of the U.S. Forest Service maintains a center for recreation research at the College. Forest Service personnel collaborate directly with faculty and students on research projects in this new area of resource management in order to develop improved methods for integrating recreation and other forest uses.

Among the many areas undertaken for investigation are the use of computer graphics for previewing the visual effects of timber harvesting throughout a rotation, and a project to obtain the reaction of managers and key interest groups to recreation management procedures that may become appropriate in the next decade.

Nelson Cortlandt Brown Laboratory for Ultrastructure Studies

This center, located in Baker Laboratory, is a teaching, research and service facility of the College. It is equipped to handle virtually every type of modern microscopy operation, including light, scanning electron and transmission electron. Among the major items of equipment are: an RCA EMU-3 transmission electron microscope; an RCA EMU-4, an ETEC autoscan scanning electron microscope, energy dispersive X-ray analyzer, several types of light microscopes, high vacuum evaporators and microtomy equipment.

The primary service of the center is teaching; course offerings include microtechnique, photomicrography, electron microscopy and interpretation of cellular ultrastructure. A second function of the center is to provide research on a service basis to faculty and students and to the community at large.

PUBLIC SERVICE

The College, throughout its 66-year history, has continued to respond to its specific legislative mission prescribing major responsibilities in the area of public service. Public education and information, technical advice and guidance to cooperating local, state and federal agencies and organizations, and technical assistance to the forest and wood-using industries constitute the principal formal public service activities. The Institute of Environmental Program Affairs (described in the Research section) coordinates the College's public service activities on the professional level.

While the list of public service contributions is lengthy, a few other examples include: the College's Film Library; the Tree Pest Service, which provides technical advice to private citizens and to governmental agencies; the participation of ESF faculty members in Central New York's Poison Control Center; and membership in PACE (Planning Approaches for Community Environments), a faculty-supervised student design and planning service to benefit community development. Altogether, the public service programs of the College reach approximately one million New York State residents each year.

The Campuses

The College has a multiple campus system with regional campuses and field stations located at Syracuse, Tully, Wanakena, Warrensburg, Cranberry Lake, Newcomb and Clayton. This system is composed of about one million square feet of facilities and 25,000 acres of land. Collectively, they represent the largest fully utilized campus in the world.

THE SYRACUSE CAMPUS

The main campus is in Syracuse, and lies on 12 acres adjacent to Syracuse University, in an area that traditionally has been known as "The Hill." Located here are the Schools of Biology, Chemistry and Ecology; Environmental and Resource Engineering; Environmental and Resource Management; Landscape Architecture; and Continuing Education. In addition, the main campus houses the Institute of Environmental Program Affairs, the Applied Forestry Research Institute, the Empire State Paper Research Institute, the State University Polymer Research Center, a cooperative research unit of the U.S. Forest Service, and an ultrastructure center.

Specialized facilities at the Syracuse campus include electron microscopes, plant growth chambers, air-conditioned greenhouses, an animal environmental simulating chamber, a bio-acoustical laboratory, a 1,000-curie cobalt-60 radiation source, radioisotope laboratory, computer center, and specialized instrumentation including nuclear magnetic resonance spectrometer, electron spin resonance spectrometer, mass spectrometer, ultracentrifuge, X-ray and infrared spectrophotometer. Photogrammatic and geodetic facilities of the forest engineering department include one of the most extensive arrays of equipment in the United States, with a Nistri TA-3 stereocomparator, Mann comparator, computerized Nistri photocartograph, and nine other varieties of plotters. The paper science and engineering laboratory has a semi-commercial paper mill with accessory equipment. The wood products engineering department has a complete strength-of-materials laboratory as well as a pilot scale plywood laboratory and a machining laboratory. The greenhouses and forest insectary are used to produce plant and insect material for classroom and laboratory. Extensive collections are available for study, including wood samples from all over the world, botanical materials, insects, birds, mammals and fishes.

The **F. Franklin Moon Library** contains more than 68,000 cataloged items. Over 800 journals and corresponding indices are currently received. The collections constitute an information center for forestry and environmental science programs in ecology, botany and pathology, biochemistry, chemical ecology, forest chemistry, polymer chemistry, economics, entomology, environmental studies, industrial pollution abatement, landscape architecture, environmental design, management, paper science and engineering, photogrammetry, silviculture, soil science, water resources, world forestry, wildlife biology, wood products engineering and zoology. These are supplemented by large collections in the environmental resource field. Additional strength is found in the comprehensiveness of abstract and indexing services relevant to the College's programs. The library also offers a selected and broad choice of general-interest reading material.

The collections of Syracuse University Libraries and State University Upstate Medical Center are within walking distance. They may be used by all members of the College of Environmental Science and Forestry. Arrangements often can be made to use industrial libraries in the Syracuse area. Other collections are accessible through the Inter-library loan privilege.

The library building, opened in 1968, can accommodate 132,000 volumes and can seat 575 persons. The main reading areas are in the center of the upper level surrounding open stacks, a current periodicals room, bibliographic center, individual study carrels and library staff offices. The archives, special collections, conference rooms, audio-tutorial center and informal study rooms are located on the lower level.

The audio-tutorial center provides facilities for study with nonbook materials. Slides and cassettes prepared as integral units of particular courses are held on reserve for use in the center. Materials are available for review on weekends, evenings and times when other facilities are closed.

Leisure reading material is distributed throughout the total collection which represent the Robin Hood and Raymond F. Crossman collections, and contain books on national and world social problems, humanities, education and popular books concerned with the environment. The archives consist of historical items relevant to the College and forestry developments in New York State. The special collections room contains rare and valuable books and folios.

Reference service, orientation and bibliographic instruction (Library Research 300) are provided by the librarians. Study guides, user aids and other such publications are prepared and distributed by the librarians as needed.

The **Educational Communications** unit directly supports the program areas of the College through development and application of media materials and methods for the classroom, for the presentation of research findings and for public service endeavors. These include television programming, slide/tape and motion picture production. Other services to the College community include engineering, A-V equipment distribution, and maintenance and support functions. The Educational Communications staff also participates directly and actively in instructional programs in environmental communication at both the undergraduate and graduate levels as well as through the School of Continuing Education.

The College's **Computer Center** has a Control Data 3200 computer system utilized in its academic and research programs, and to a moderate extent, for its administrative data processing needs. The instructional work consists of courses which teach the use of computers and those which use the computer to assist in teaching applied subjects. The major use is in the graduate programs where students perform research in areas such as hydrology, transportation networks, forest and tree growth studies, genetics, disease and insect behavior and controls, land use, production and processing techniques, polymer and cellulose chemistry, cellular ultrastructure, photogrammetry and remote sensing, landscape architecture, and other supporting and related fields.

THE TULLY CAMPUS

Located about fifteen miles south of Syracuse is the Tully Campus composed of the Heiberg Memorial Forest, classrooms and research facilities.

Heiberg Memorial Forest has a diversity of terrain and forest growth and is utilized both as an extensive outdoor teaching laboratory and as a site for intensive research. Located there are plantings from known seed sources from many parts of this country and throughout the world.

THE WANAKENA CAMPUS

The Wanakena Campus is located on the Oswegatchie River, 65 miles northeast of Watertown, New York and 35 miles west of Tupper Lake, New York. This campus, with its large instructional and demonstration forest, supports the College's **School of Forest Technology**, the oldest forest technician school in the country. It is on this campus that forest technicians are trained in an associate degree program.

THE WARRENSBURG CAMPUS

Each summer, the Warrensburg Campus hosts a program devoted to the field application of environmental principles and practices for students majoring in resource management and environmental biology. Formal continuing education courses also are held here for such groups as State foresters, mill owners and logging operators.

The Warrensburg Campus also contains the **Charles Lathrop Pack Demonstration Forest**, which, since 1927, has been under intensive management for the combined purpose of instruction, demonstration and research.

THE CRANBERRY LAKE CAMPUS

The Cranberry Lake Campus, accessible only by water, is the site of the College's biological station, where, every year, a cooperative program in environmental biology is sponsored jointly by the College and other institutions of higher education. Bounded by 150,000 acres of forest preserve, by Cranberry Lake, and by isolated forest bogs and beaver meadows, the extensive facilities are intensely utilized in a comprehensive curriculum of upper-level and graduate courses.

THE NEWCOMB CAMPUS

Located in the central Adirondack Mountains, Newcomb is the largest of the regional campuses and home to the **Adirondack Ecological Center**

where extensive studies of animal biology and ecology are carried out. Located there also is the **Archer and Anna Huntington Wildlife Forest**.

THE FIELD STATIONS

In addition to its Regional Campus System, the College operates several field stations which directly support the programs of the institution. The 44-acre **Forest Experiment Station**, located only a few minutes drive from the main campus, is used to support main campus academic programs. Located at the Station are a large arboretum, tree nursery and experimental greenhouse facility. Adjacent to the Tully Campus is the College's **Genetic Field Station**. With its irrigation system and layout of level blocks, it is an excellent facility for developing hybrids, for grafting experiments, and for research in heritability. A magnificent island, the **Ellis International Laboratory**, is situated in the heart of the Thousand Islands-St. Lawrence River area off the village of Clayton. Accessible only by water, this laboratory, which is the College's most recent property acquisition, is an unusually appropriate site for the College-wide, cooperative and international environmental monitoring and research activities.






Larry's
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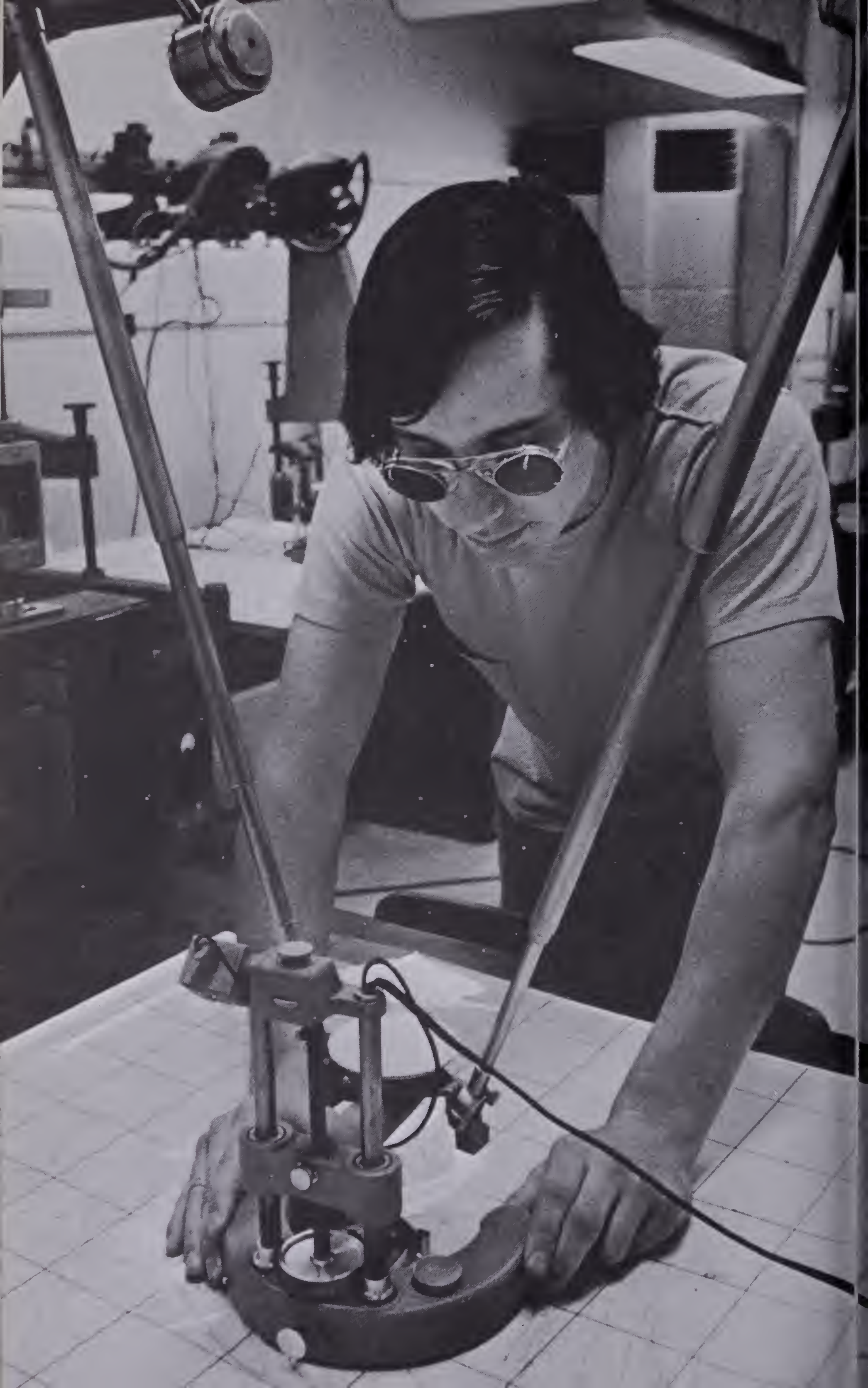
SANDWICHES
TAKE OUT & DELIVERY
OUR SPECIALTY

The Syracuse Metropolitan Area

The College of Environmental Science and Forestry is located on one of several hills that overlooks Syracuse, a growing metropolitan area of nearly 500,000. Known as the "Salt City" because of the great salt industry which was centered here for more than seventy years, Syracuse is today a city of diversified industry and commerce. The area is a leader in the manufacture of china, quality shoes, air-conditioning equipment, medical diagnostic equipment and decorative home accessories.

The City of Syracuse offers students many cultural, recreational and educational opportunities, including a symphony orchestra, several museums, live theater and historical points of interest.

Called the "Crossroads of New York State," Syracuse is one of the few cities in the nation situated at the crossing point of two major super-highways. It is located at the intersection of the 500-mile east-west New York State Thruway and the north-south Penn-Can Highway. Driving time from New York City, Philadelphia and Boston is about five hours; from Buffalo and Albany about three hours. The city is served also by a modern international airport and major bus and rail lines.



Graduate Study at ESF

Society is increasingly in the hands of those who have broad foresight and a balance of judgment in applying sociological and technical knowledge to guide human and environmental forces. Modern civilization—with its compelling demands from industry, government and educational institutions—requires people who think objectively and constructively, and who act creatively and responsibly.

A purpose of the graduate years is to develop these persons. These years are a time of discovery and excitement, a time of answers and new insights, a time of personal productivity and contributions to scholarship. It is during the graduate education that the student sharpens the ability to think critically and analytically, to plan research, to design experiments, to work effectively with the basic research tools as well as specialized equipment, and to undertake the discipline of purposeful study toward a specific goal.

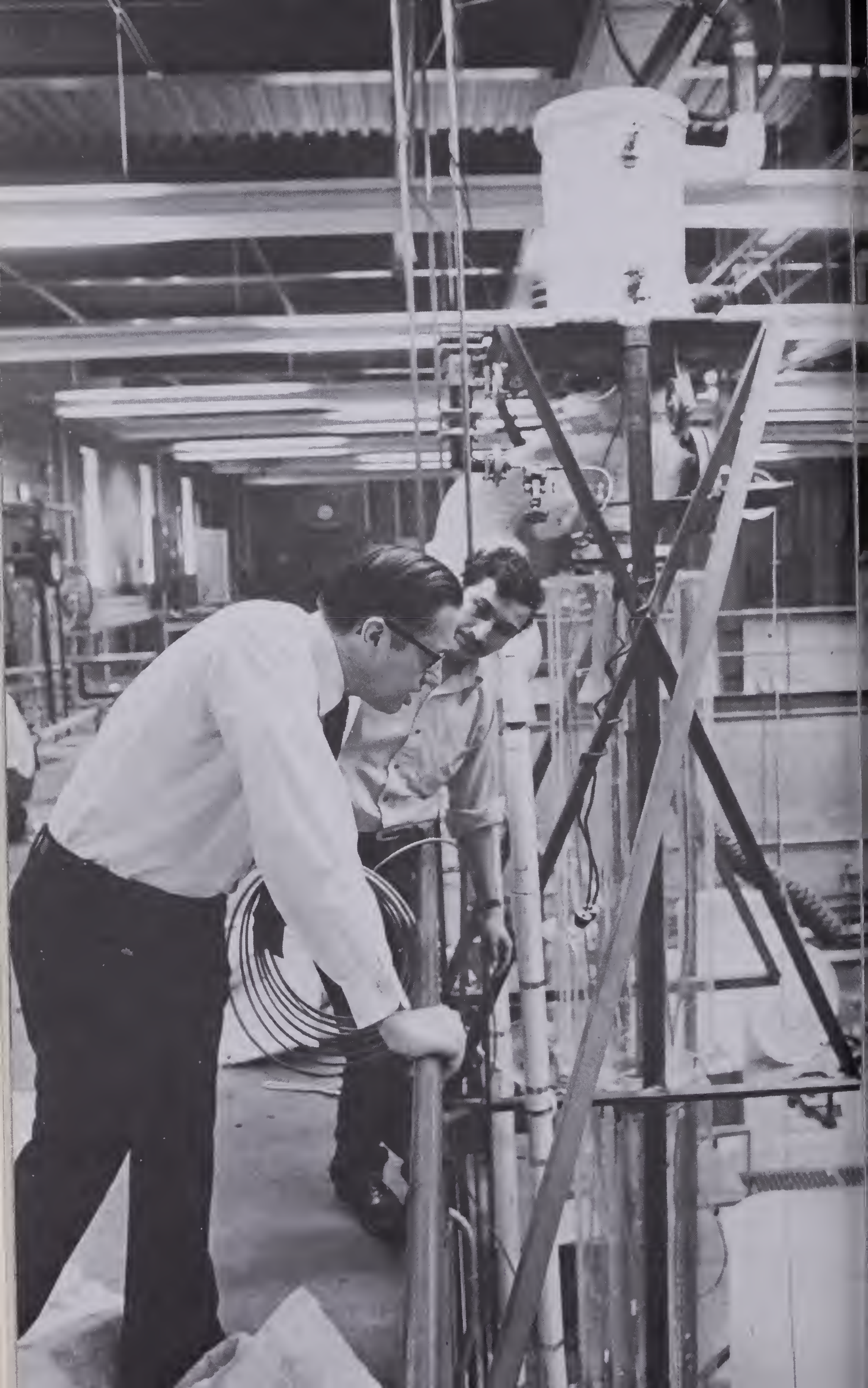
From its beginnings in 1911, the State University of New York College of Environmental Science and Forestry has served New York State and the nation in meeting the needs of its citizens in regard to the environment through education, research and public service. The faculty and students of the institution are committed to the resolution of immediate environmental problems, the development of the knowledge necessary to predict occurrences in the future, and the presentation of public policy alternatives that will both protect the environment and accommodate the real needs of society.

The major impetus for this inquiry lies in the research programs of the College in which the graduate students play an integral role with the faculty. The College has more than 150 faculty whose research interests in various aspects of environmental science involve more than 400 graduate students in master and doctoral degree programs.

The College currently supports significant graduate degree programs in six subject areas and, in addition, its broad program in Environmental Science encourages the development of multidisciplinary graduate research in several study areas.

The diversity and depth of the graduate programs of the College reflect the work of its excellent faculty and their graduate student colleagues utilizing some of the most modern facilities and laboratories in the country. They maintain a long-standing tradition of academic and professional excellence.

This bulletin provides an introduction to the College and its programs of graduate study and research. It only begins to suggest the diversity and depth of the existing and potential programs that make environmental science the *challenge of the 70's* and beyond.



Requirements for Degrees

Graduate programs are flexible and developed individually. Each program is planned by the major professor with the student to meet the individual's particular academic and professional needs. Sometimes this includes undergraduate courses for which no graduate credit can be given. In every case, emphasis is placed on outlining a study program leading to a high level of scholarly achievement.

An entire program for each student is planned and must be approved by the major professor, department chairman and School Dean. The program is modified as required upon recommendation of the major professor. A thesis committee composed of the major professor and two other faculty members is appointed early in each student's study program. In some departments, all graduate students are required to engage in an appropriate teaching assignment as an academic degree requirement.

THE MASTER'S DEGREE

All programs leading to the Master of Science (MS) and Master of Landscape Architecture (MLA) degrees require at least 30 semester hours of graduate credit and two semesters in residence. From 6 to 18 hours of graduate credit may be earned through completion of a thesis or special project. The remaining credit hours are earned through completion of course work (passed with an average grade of B, or better). A total of at least 15 hours of credit, including thesis and special project credits, must be in courses numbered at the 600 level or above.

Students must also pass a final oral examination defending the thesis and demonstrating knowledge of related subject areas. Acceptance of the thesis or special project requires a clear demonstration of ability to evaluate pertinent literature, to plan and execute an independent investigation, to interpret the significance of findings and to report the foregoing in a well-organized and lucid manner.

DOCTOR OF PHILOSOPHY DEGREE

In pursuing the Ph.D. degree, the student is required to work on the frontiers of knowledge in a particular field of study and to make a contribution to this knowledge. This is accomplished through original study including the search and evaluation of literature; the conception, planning, execution, and interpretation of high quality research; and the presentation of the above in a well-organized and well-written dissertation. Subsequent publication of research findings in an appropriate journal is expected.

There is no minimum credit hour requirement for the Ph.D. Each student must pass a qualifying examination before being admitted to candidacy. This two-part examination consists of a preliminary examination taken early in the period or residence to assist in planning a course work and independent study program, and a written and oral comprehensive examination to test breadth and depth of knowledge. There is no College-wide language requirement. However, competence in a foreign language, statistics, computer programming or other "tools" may be required where they are relevant to the student's field of study. Students seeking the Ph.D. degree must be in residence for at least two semesters, and must matriculate for a minimum of three academic years. The final requirement is the presentation and defense of the thesis or dissertation.

Admission

REQUIREMENTS

The College of Environmental Science and Forestry, since its founding, has continually practiced open and competitive admissions regardless of race, color, sex, religion, national origin, handicap, or age. Pursuant to Title IX of the Education Amendments of 1972 and accompanying regulations: No person shall be denied the benefits of or be subjected to discrimination under any academic, extra-curricular, research, occupational training or other educational program or activity operated by this institution.

Admission to graduate study may be granted only to applicants with at least a bachelor's degree from a recognized institution, and whose preparation has been suitable in quality and content for the proposed field of major study. Applicants will be evaluated on the basis of the following: (1) their academic record should show at least a B or 80 percent average for the junior and senior years; (2) Graduate Record Examination Aptitude scores, and, in some cases, subject matter (advanced) tests indicative of graduate study ability (see below); (3) supporting letters of recommendation; (4) a statement of specific educational and professional goals which describes the choice of degree program and the students' plan for the pursuit of the objectives in the program; and (5) where appropriate, other evidence of scholarly achievement and potential. Admission is selective with priority given to applicants who have high scholastic standing.

ADVANCED TESTS

Subject matter (advanced) test scores are required by the following programs:

Graduate Programs	*Advanced Test*
Chemistry	Chemistry
Environmental and Forest Biology	Biology

PROCEDURE

All applicants are required to submit Graduate Record Examination aptitude scores. This examination is offered several times each year in major cities of the world. For information on registration and scheduling write to the Educational Testing Service, Princeton, New Jersey 08540. Test scores should be sent to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry,

Syracuse, New York 13210 (Institutional number R2530).

The College provides a special form for application for graduate work. Requests for information and applications should be addressed to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

INTERNATIONAL STUDENTS

Citizens of other countries with special educational objectives are accepted for graduate study in all programs. They must show satisfactory evidence that they have completed studies in their major field equivalent to those at a recognized American institution with a scholastic record equivalent to a B average in their junior and senior years. They must submit Graduate Record Examination scores as explained in the section on Admission Requirements. Also, applicants whose native language is other than English must submit scores on the Test of English as a Foreign Language (TOEFL). This requirement may be waived if the student has received a degree from an American institution. This examination is offered several times each year in major cities of the world.

For information on registration and scheduling, write to the Educational Testing Service, Princeton, New Jersey 08540, U.S.A. In submitting test scores, request that they be sent to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

Foreign student advisement is provided through the Office of Student Affairs.

Expenses

TUITION AND FEES

The tuition and fee structure at the College includes library, health, infirmary, physical education, special testing and other services, as well as an assessment for student activities and charges for expendable supplies and equipment.

Graduate tuition for New York State residents is $700 per semester. Nonresident tuition is $900 per semester. All graduate students pay activity fees of approximately $28 per year and a $25 SUNY College fee.

COMMENCEMENT FEE

Candidates for both master's degrees and doctoral degrees pay a $10 commencement fee. Additional costs are incurred for the binding, abstracting, and microfilming of theses and dissertations.

HOUSING

The College does not operate student residences. These facilities are offered by Syracuse University, and cost varies according to the type of room or apartment. Furnished and unfurnished apartments for single graduate students and for married graduate students and their families are located on the South Campus, approximately two miles from the Main Campus, and are serviced by a regular shuttle-bus.

Any student who wishes to live in Syracuse University housing should write to the Director, Office of Residential Life, Steele Hall, Syracuse University, Syracuse, New York 13210. Formal admission to graduate study is required before such requests are acted upon.

In addition, a wide variety of living arrangements in private homes and apartment complexes is available in the metropolitan Syracuse area.

OTHER COSTS

All graduate students are required to have health and accident insurance. Graduate fellows funded through the State University Research Foundation are required to take the health and accident insurance available through the Foundation.

The costs of textbooks and supplies may average $175 or more a year.

Financial Assistance

The College awards a substantial number of assistantships, fellowships and scholarships to qualified graduate students each year. The number of students receiving these awards varies from year to year, but usually more than half of all graduate students have received such support. In many cases it is not possible to provide a stipend at the start of the graduate study period, but such support is often provided after the student has demonstrated his competence.

Students may indicate their interest in a type of financial assistance on the last page of the graduate application form. Students on fellowships or assistantships must devote full-time to graduate study. Students seeking financial assistance should be sure their application and supporting documents reach the Office of Academic Programs before May 1, to ensure full consideration for an award for the fall semester.

GRADUATE ASSISTANTSHIPS

Assistantships are awarded to students of demonstrated scholarship and whose education and experience enables them to assist in laboratory instruction and research. The amounts of the assistantships range from $2600 to $4000 per year. In addition, a significant portion of tuition may be waived. Masters students on assistantships must carry a minimum of 12 credit hours per semester, while Ph.D. students must carry at least nine credits, and in some cases 12 credits, depending on their academic achievement beyond the baccalaureate degree.

SPECIAL FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships and assistantships sponsored by industries, associations and foundations are available in several departments. The amount of stipends varies. Holders of these special fellowships and assistantships are required to confine the major part of their research activities to specified fields. A significant portion of tuition is usually waived by the State University or provided by sponsors.

TUITION WAIVER SCHOLARSHIPS FOR INTERNATIONAL STUDENTS

Tuition waivers may be awarded to a limited number of international students judged to possess special academic capabilities and with demonstrated financial need, who are prepared to contribute to furthering international understanding and good will. Requests for such tuition waivers may be made on the last page of the graduate application forms.

TUITION ASSISTANCE PROGRAM

Qualified New York State residents are eligible for Tuition Assistance Program grants which vary with the net taxable family income of students, and the level of study, and provide substantial reductions in tuition. For details, contact the Coordinator of Financial Aid at the College. (New York State residents holding graduate assistantships must apply to the Tuition Assistance Program in order to qualify for a graduate tuition waiver.)

LOANS

Graduate students may be eligible for various types of educational loans. The New York Higher Education Services Corporation offers loans to New York State residents of up to $5,000 per year. The current interest rate is eight percent, and repayment begins nine months after

leaving college. Depending on income level, Federal interest benefits may apply.

A graduate student who is a U.S. citizen may borrow up to $2,500 a year under the Student Loan Program of the National Defense Education Act of 1958. No interest will accrue until nine months after leaving college, and then it is at three percent. Part of the loan will be canceled if the student becomes a public school teacher or college teacher or enters military service. A ten-year repayment period is allowed.

OTHER FORMS OF SELF SUPPORT

Many graduate students support their studies through part-time employment at the College in laboratories and other College activities. Employment may also be sought outside the College on a part-time basis. Contact the Coordinator of Career Services for details and availability.

The College also participates in the Federal Work-Study Program which is designed to enable students to partially defray their educational expenses through part-time jobs during the academic year. Applications and further information are available from the College's Office of Financial Aid.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Graduate Degree Programs

COLLEGE-WIDE PROGRAMS

Graduate Program In Environmental Science

ROBERT D. HENNIGAN, *Director* (Managerial Science and Policy)

A Perspective

Environmental science is the study of man and his relations with his environment. The environment is the physical, biological and social setting in which man exists. This ranges from the solar system to the neighborhood, from Mars and Venus to the backyard tree, and it includes all points in between.

Environmental science connotes a holistic orientation, that is one that recognizes the togetherness and interrelatedness of all the facets of man and his environment, as opposed to an atomistic orientation which treats all facets as fragmented and unrelated.

At the College of Environmental Science and Forestry, the environmental science program includes: physical sciences (chemistry, geology, physics, meterology, and geography); biological sciences (botany, zoology, ecology, bacteriology, biology); social sciences (economics, political science, communications, law, history, sociology, philosophy and religion); and quantification and application sciences (engineering, forestry, medicine and public health, systems analysis, operations research, policy analysis, management and administration, and planning).

Environmental science is the multidimensional matrix consisting of the natural setting, the culture imposed by man on this setting and lastly, the institutional system man has devised to order the relationships between many conflicting demands and desires in light of natural and social constraints. Few, if any, locations on this earth are totally independent; external dependencies exist, to a greater or less degree and must be factored into the environmental matrix.

Armed with this perspective, it is apparent that the environmental problems facing society today are a product of human interaction with the environment, not simply a number of technological difficulties. They derive from the interaction of technological and social factors having economic, political and legal ramifications.

The Environmentalist

In light of the broad scope and thrust of environmental science, how can one become proficient and expert in all its aspects? Can we create new renaissance men and women? The answer to these questions is simply that no one can become the do-everything environmentalist. This idea collapses in the face of technological and social complexities. What one can do is develop a basic competence in one aspect of environmental science while developing an understanding and appreciation of other interrelated elements.

The Program

The graduate program in environmental science is an integrated, interdisciplinary scheme of course work and research technique to each student. *It is designed to help the student develop a basic competence in one aspect of the environmental complex while developing an understanding of other interrelated elements.* The research component of the program encourages individual accomplishment and frequently brings together students from diverse backgrounds in teams or task forces to research a particular environmental problem. In the process each develops insights through study of the total problem. The student develops an enhanced understanding of environmental problems and valuable experience in seeking their solution.

The program is designed to be flexible; it enables the student to apply *prior academic training and work experience in a discipline* to the solution of an environmental problem, while developing additional training with broader implications.

The program in environmental science offers a wide range of study opportunities and draws upon, and involves faculty, course work, facilities and philosophies of all the disciplinary degree programs. The relevant pieces of these programs and the strength of them provide the necessary disciplinary support to make the concept of "interdisciplinary program" a viable entity.

Other important inputs to this program are the resources of Syracuse University in the course work areas of communications, policy, law, sociology and political science, and the community and institutional resources of the region such as federal, state and local agencies, faculties of other colleges and private organizations.

Program Units

The graduate program in environmental science is presently organized into five program units: (1) Environmental Land Use Planning; (2) Environmental Education/Communications; (3) Environmental Assessment and Impact Analysis; (4) Water Resources; and (5) Remote Sensing. Each program unit is directed by a program leader and assisted by three to four other faculty members. Each student will enroll in one of these program units.

The faculty for the graduate program in environmental science is drawn from the faculty of the existing schools and departments; GPES has no full time faculty assigned. The departmental affiliation of each faculty member is noted in parentheses following the individual name.

Remote Sensing

LILLESAND, *Leader* (Engineering); BLACK (Silviculture and Forest Influences); FELLEMAN (Landscape Architecture); MANION (Botany)

The Remote Sensing Program Unit is concerned with the use of remote sensing technology for the continuous measurement and acquisition of environmental and resource inventory and monitoring data and the application of these data to the solution of environmental problems. The basic emphasis is on electromagnetic remote sensing of the environment from aircraft and satellites, including photographic and nonphotographic remote sensing data acquisition, remote sensing data processing, remote sensing data analysis and the transformation/presentation/communication of these data in a meaningful form to a wide variety of user groups. This involves consideration of the characteristics of applicable remote sensing technology including physical, organizational, economic and socio-political limitations; the characteristics of the desired data including definition, resolution and distribution; and the characteristics of the institutional and individual data users.

The need for remote sensing inventory and monitoring systems capable of covering large areas in real time and for effective system linkages to institutions capable of appropriate action are paramount to the development of effective methods for the protection of the environment.

Environmental Education/Communication

HANSELMAN, *Leader* (Managerial Science and Policy); JELINEK (Engineering); HARPER (Landscape Architecture); DALL (Managerial Science and Policy); CHAMBERS (Zoology)

The Environmental Education/Communications area of study is concerned with those facets of environmental protection, enhancement, management and design in which the flow of information and the processes of education are integral to end results. The basic emphasis is to integrate a solid and substantial background in Environmental Science with a mastery of appropriate education and communications theory and practice in such a manner as to prepare students in the program for careers in environmental education and communications.

Although closely related, there are several rather distinct career areas under the umbrella of EE/C for which this program unit provides preparatory graduate degree training. These career areas can be generally categorized as follows: Public Information Officer, Environmental Education Specialist, Extension Specialist, Interpretative Naturalist, Environmental Journalist.

Water Resources

BLACK, *Leader* (Silviculture and Forest Influences); NEIMAN (Landscape Architecture); TULLY (Engineering); WERNER (Zoology); HENNIGAN (Managerial Science and Policy)

The Water Resources Program Unit is based on the recognition that water relationships are important in almost every aspect of human concern and merit attention as integrative and central-elements rather than accessories.

The thrust of the program is either technical or social depending on student interest. The technical is concerned with water quality and quantity relationships, their quantifications and determinants. The social aspect is concerned with planning, regulation, law and institutions, and management. National concern with water resources planning, water supply and water pollution control attest to the need for people trained in these areas.

Environmental Assessment and Impact Analysis

HERRINGTON (Silviculture and Forest Influences) and JOHNSON (Chemistry); *Co-Leaders*: DENCE (Engineering); NAKATSAGAWA (Entomology); DINDAL (Zoology); HARTENSTEIN (Zoology)

The main objective of the program is to bring together in an organized educational unit the various skills and disciplines required for an Environmental Impact Analysis. In practice, such an analysis is a team effort and the program is intended to ensure that potential team members are conversant with and operationally adapted to the language and procedures of a number of the disciplines involved. Starting with students who have an in depth background in a traditional (i.e., chemistry, biology, engineering, ecology, forestry, *et al.*) discipline, the program seeks to refine existing strengths while at the same time broadening the students' ability to deal effectively with the complex, interdisciplinary problems which arise in studies of environmental impact. To ensure the depth and breadth aspects simultaneously, the academic plan stresses a problem oriented team research approach.

Environmental Land Use Planning

LEWIS, *Leader* (Landscape Architecture); CANHAM (Managerial Science and Policy); HARPER (Landscape Architecture); HERRINGTON (Silviculture and Forest Influences); LILLESAND (Engineering)

The land use planning program is based on the concept that land use is a fundamental determinent of environmental conditions be it water pollution, air pollution, population density, solid waste disposal, or other impacts. The program is designed to acquaint the student with the physical elements of land use such as location and natural resources, and the social side relating to law, economics and regulation. Land use management and control is fast becoming the major environmental issue of the day. Land use planners and implementors are sorely needed on a local and regional level. This program unit proposes to meet that need.

The Student

A major professor is assigned by the appropriate program unit leader to accept primary responsibility for the program of each student. Two additional faculty members in areas of expected academic or research emphasis are also selected. These three faculty members constitute the academic program committee for the student. The student is required to submit a formal proposal to the program committee consisting of a detailed plan describing and defending the academics and research objectives and a schedule of courses to be taken. This report is reviewed by the program committee. The plan is reviewed and updated at the beginning of each semester. The program committee also serves as the thesis or project committee.

Each program unit operates within the collegewide requirements for graduate students. However, each unit has a particular academic plan specifying requirements for admission and matriculation.

All students in the program are required to participate in the environmental science seminar which brings together a variety of lecturers in environmental science with a wide spectrum of interests.

Communication and a campus visit and an interview are highly reccommended prior to or during the application process.

SCHOOL OF BIOLOGY, CHEMISTRY AND ECOLOGY

STUART W. TANENBAUM, *Dean* (Microbial Ecology and Metabolism)

The School of Biology, Chemistry and Ecology is made up of the departments of chemistry; botany and forest pathology; entomology; and forest zoology. There are two degree programs offered by this School. The first is chemistry and the second is environmental and forest biology. Each of these programs offers the M.S. and Ph.D. degrees. The program of study is built upon the full array of courses and other resources available within the School.

BIOLOGY, CHEMISTRY, ECOLOGY

DEPARTMENTS and current degree programs	CHEMISTRY	BOTANY AND FOREST PATHOLOGY	ENTOMOLOGY	FOREST ZOOLOGY
CONCENTRATION AREAS	Environmental Chemistry Natural Products Natural and Synthetic Polymers Biochemistry	Anatomy and Morphogenesis Forest Pathology Wood Deterioration Mycology Physiology Taxonomy Genetics	Forest and Shade Tree Entomology Medical Entomology Environmental Entomology Biological Control Population Dynamics Behavior Taxonomy Toxicology Wood Deterioration	Bioenergetics Limnology Wildlife Management Animal Behavior Fishery Biology Soil Invertebrate Biology Animal Physiology

MULTIDISCIPLINARY CONCENTRATIONS

- Ecology
- Chemical Ecology
- Environmental Biochemistry and Physiology
- Pest Management

Botany and Forest Pathology

TEPPER, *Chairman* (Anatomy and Morphogenesis); AMES (Morphogenesis); GEIS (Ecology); GRIFFIN (Mycology and Fungus Physiology) KETCHLEDGE (Ecology and Bryology); MANION (Pathology); RAYNAL (Ecology and Taxonomy); SCHAEDLE (Physiology); SILVERBORG (Pathology); VALENTINE (Genetics); WALTON (Physiology); WANG (Mycology); WILCOX (Physiology of Growth and Development); ZABEL (Wood Deterioration)

The area of study in botany and pathology is designed to provide students with graduate level instruction in basic botanical and related natural and physical sciences. Research and thesis problems are generally designed to utilize forest organisms in the development of biological knowledge. Opportunities for graduate study within this area are offered in the fields of anatomy, morphogenesis, physiology-biochemistry, ecology, forest pathology, wood deterioration, mycology, genetics and taxonomy. Courses in climatology, meteorology, soils, ecology, bacteriology, botany, microbiology, genetics, mathematics, chemistry and statistics, all available in other departments at the College and at Syracuse University, provide additional support for this department.

Current areas of active research by departmental faculty are: *anatomy and morphogenesis*—factors that influence the development and form of root systems and regulate the development of root and shoot apices, cell differentiation in tissue culture; *physiology*—chemical regulation of organ growth, the nature and physiology of mycorrhizae, ion transport, mineral nutrition, biochemical aspects of cambial physiology, photosynthesis; *ecology*—dynamics of plant communities in the Adirondack Mountain Region and on the Allegheny Plateau, the influence of man on plant communities, the interaction of environmental factors during vegetational change, phytogeography and chemical ecology; *forest pathology*—disease of forest plantations, heart rots and cankers, tree rusts and physiogenic diseases; *wood deterioration*—the effects of stains and decays on wood use and their controls, the chemistry of wood decay, toxicity mechanisms and the bio-assay of toxicants; *mycology*—the taxonomy, sexuality, and morphology principally of wood-inhabiting fungi and microfungi; *fungus physiology*—the role of nucleic acids and intermediary metabolism in growth and morphogenesis; *genetics*—quantitative and population genetics, the heritability and natural variations in wood characteristics that are important in forest products and wood pulp; *taxonomy*—the identification, nomenclature and classification principally of fungi, bryophytes and vascular plants.

Illick Hall, the biological science building, provides faculty and students with modern facilities for botanical research. Special facilities include rooftop greenhouses, growth chambers, herbaria and special research laboratories for tissue culture, microchemistry, microtechnique, microscopy, radiochemistry, chromatography and computation. In addition, a cobalt-60 source, electron microscopy laboratory and a computer center are available at the College for student use. Extensive

College forests, including most forest types of the Northeast, plantations and nurseries, offer exceptional opportunities for field study of forest plants and diseases.

Research in botany and forest pathology is supported by private industry, the U.S. Forest Service, the New York State Department of Environmental Conservation, the Research Foundation of the State of New York, a variety of Federal agencies and by the State of New York. In addition to direct project support, the grantees also provide for graduate research assistantships.

Entomology

SIMEONE, *Chairman* (Ecology and Wood-inhabiting Insects); ALLEN (Ecology and Population Dynamics); BREZNER (Physiology); CAMPBELL (Population Dynamics); JAMNBACK (Diptera Ecology and Control); KURCZEWSKI (Morphology, Taxonomy, Behavior); LANIER (Ecology, Cytotaxonomy); MILLER (Pest Information and Control); MORRIS (Medical Entomology); NAKATSUGAWA (Toxicology); NAPPI (Physiology and Pathology)

Opportunities for graduate study are available to students with interests in basic aspects of insect life and the roles insects play in relation to man and his environment. Research emphasis lies in biological and functional studies of selected insects, including host selection, insect-host-parasite relationships, insect physiology, biochemistry, toxicology and detoxification mechanisms; comparative systematics and behavior; communications; and histology and cytogenetics. Problems may concern forest, shade tree and wood-products insects, those relating to the well-being of vertebrates, including man; cultural and sanitary methods of prevention; biological, ecological (including pheromones), and chemical methods of control; and integrated pest management.

Interdisciplinary pursuits are encouraged in chemical ecology, genetics, forest pathology, vertebrate entomology, immunology and climatology involving other departments at the College, Syracuse University, and nearby Upstate Medical Center of State University of New York. Areas of specialization are enhanced by supporting courses in these other disciplines. Students interested in insect ecology, chemical ecology, physiology or taxonomy, for example, may pursue these subjects relative to plants and other animals by selecting courses in botany, silviculture, zoology, biochemistry and applied mathematics.

Students and faculty have a wide range of field and laboratory facilities available for research. The several forest properties represent varied forest environments, while Illick Hall provides modern controlled facilities and instrumentation. More than 18,000 square feet of indoor space is available, with access to an electron microscopy laboratory and scanning electron microscopes, environmental chambers, ultracentrifuges, nuclear magnetic resonance equipment, gas chromatograph, isotope laboratory, a cobalt source for irradiation, a soundproof room, glasshouses and an insectary complex affording subjection of insects to controlled as well as ambient weather conditions. The taxonomic museum houses nearly 100,000 insects species deposited by entomologists for more than half a century. A computer center provides services in all phases of entomological research.

Forest Zoology

ALEXANDER, *Chairman* (Vertebrate and Wetland Ecology); BEHREND (Wildlife Ecology and Management); BROCKE (Bioenergetics and Wildlife Ecology); CHAMBERS (Wildlife Ecology and Management); DINDAL (Invertebrate Ecology); HARTENSTEIN (Invertebrate Physioloy); MATTFELD (Bioenergetics and Wildlife Ecology); MITCHELL (Bioenergetics and Invertebrate Ecology); MULLER-SCHWARZE (Animal Behavior and Chemical Ecology); PAYNE (Wildlife Conservation); RINGLER (Fishery Biology); TIERSON (Wildlife Conservation); Van DRUFF (Vertebrate Zoology and Wildlife Ecology); WERNER (Limnology and Aquatic Ecology)

Graduate studies in zoology include both basic and applied research on animals of our natural ecosystems, including their associated soils and water. Concentrations are offered in vertebrate ecology, soil invertebrate ecology, physiology, population ecology, animal behavior, wildlife biology, aquatic ecology, wildlife management and fishery biology.

Many of the faculty and students are located in Illick Hall, the biological sciences building. Facilities include specialized laboratories for research in physiology, soil invertebrate ecology, animal behavior, aquatic biology and wildlife biology. An extensive collection of invertebrates is available, as well as the large Roosevelt Wildlife Collection. Various temperature-humidity chambers are available, including an environmental simulating chamber which programs and records light, temperature, humidity, altitude, wind and precipitation.

Graduate students may participate in an intensive research program in wildlife biology at the Archer and Anna Huntington Wildlife Forest Station, a 15,000-acre forest in the Central Adirondack Mountain region. Many forest types are present in varying stages of management. Three faculty members are year-round residents.

Field research may also be conducted at the College's Heiberg Memorial Forest and Experiment Station. Several other areas are located within a 35-mile radius of Syracuse, and frequently are used for research purposes. These include Onondaga County's Highland Forest; the Department of Environmental Conservation's wildlife management areas—Tioughnioga, Three Rivers, Howland Island and Cicero; the Montezuma National Wildlife Refuge; and privately-owned lands. A wide variety of ponds, streams and lakes in Central New York are regularly used by graduate students in aquatic ecology and fishery biology. Also, various forests, fields, aquatic areas and waste beds are used for invertebrate investigations.

These facilities and areas are supplemented by the services and facilities of the College's other departments, particularly the departments of botany and forest pathology, and entomology. The School of Environmental and Resource Management provides support in relating the managerial and silvicultural facets of forest resources to animal ecology and wildlife study programs. The College is adjacent to Syracuse University with its large departments of biology, strong in physiology and developmental zoology. Available through this institution are programs in social sciences and engineering, including land use and environmental pollution.

The State University Upstate Medical Center also is nearby. Its facilities are available for graduate students whose research can benefit from the specialized library, equipment and faculty.

Examples of recent research include taxonomy and ecology of larval fish, trout management, limnology of lakes, succession in ponds, domestication, bird nesting behavior, deer behavior and bioenergetics, deer pheromones, wilderness wildlife, wild canid biology, ruffed grouse ecology, urban wildlife, waterfowl ecology, wetland ecology and planning, physiology of crustaceans, pesticides and soil fauna, soil invertebrate ecology and organic decomposition.

An interdisciplinary master's program in Fish and Wildlife Managerial Science is being developed.

Chemistry (Polymers, Natural Products, Biochemistry)

SMITH, *Chairman* (Physical and Polymer Chemistry); CALUWE (Organic Polymer Chemistry); FLASHNER (Biochemistry); LaLONDE (Organic and Natural Products Chemistry); LEVIN (Physical and Polymer Chemistry); SARKO (Physical and Polymer Chemistry); SCHUERCH (Wood and Polymer Chemistry); SILVERSTEIN (Ecological Chemistry); SMID (Physical and Polymer Chemistry); SZWARC (Physical and Polymer Chemistry); TANENBAUM (Microbial Chemistry); TIMELL (Wood Chemistry)

Recent years have seen profound advances in the fundamental knowledge of chemical areas which have special significance for forestry and the environment. The following research areas have received active attention by both faculty and graduate students in the programs: polymer chemistry and physics, wood chemistry, environmental chemistry, biochemistry, chemistry of natural products including ecological chemistry, and materials sciences.

Requirements for a master of science or doctor of philosophy degree in chemistry include a research project and thesis, along with an appropriate program of courses at the College and at Syracuse University.

Specific projects may vary from year to year, since they reflect the current interests of the faculty. Current research projects with *physicochemical* emphasis are: the chemistry, physics, solid state and solution properties of natural and synthetic polymers, including studies in thermodynamics, statistical mechanics, crystallization, morphology, elasticity, conformation of macromolecules, optical properties, polymer catalysis, mechanism of polymerizations, polyelectrolytes, ion binding to macromolecules and ion pairing; chemistry of free radicals, radical ions and charge transfer processes; structure and properties of ionic solutions in nonaqueous media; crystal structure and morphology of cell wall constituents; heavy metal speciation. Current *organic* chemistry programs deal with synthesis of special polymers such as high temperature aromatic block, stereoregular vinyl polymers, and polysaccharides, various aspects of natural products chemistry, but especially alkaloids and terpenes, isolation and characterization of insect and mammalian attractants. An active program on the structure and topochemistry of the *polymeric* wood components, hemicelluloses, lignins and celluloses is underway. In *biochemistry*, department members are studying mechanisms of action of plant growth hormones, biochemical regulation of seed germination, plant enzymology and ultrastructural plant cytology.

Graduate research laboratories in the Hugh P. Baker Laboratory are well equipped for polymer studies, chemical and biochemical research. Instrumentation includes analytical and preparative ultracentrifuges, Warburg respirometer, recording infrared and ultraviolet spectrophotometers, mass spectrometer, differential refractometer, electron spin resonance spectrometer, nuclear magnetic resonance spectrometer, automatic membrane osmometers, solid and solution state light scattering photometers, recording polarimeter and optical dispersion spectrometer, several ultramicrotomes, electron microscopes, X-ray diffraction, instrumentation chromatography and cold laboratories, and radiochemical laboratories with counters for solids, liquids and gases.

SCHOOL OF ENVIRONMENTAL AND RESOURCE ENGINEERING

WILFRED A. CÔTÉ, *Dean* (Cellular Ultrastructure, Light and Electron Microscopy)

The graduate program in environmental and resource engineering is concerned with optimum development and utilization of the forest and other natural resources. The academic objective is to provide graduates with a sufficient understanding of the methodologies of scientific research and of the principles of engineering. The School program offers unique opportunities for individuals who seek advanced education in such areas as water resource engineering, photogrammetry and remote sensing; and in the materials science and engineering of wood products, paper and related fibrous materials. Science and engineering are the foundation for the individually-designed programs so that applicants with backgrounds in engineering, chemistry, physics, mathematics, forestry or natural sciences can make an easy transition to desired areas of concentration. However, other backgrounds can also be accommodated.

Advanced studies toward an M.S. or Ph.D. degree in environmental and resource engineering may be based on a broad-gauged program emphasizing general aspects of the effective utilization of natural resources or may have a sharply focused research orientation. In either case, the student is able to draw on the combined resources of the three academic departments of the School: Forest Engineering, Paper Science and Engineering, and Wood Products Engineering. In addition, courses and facilities of other schools of the College as well as Syracuse University complement those of the School of Environmental and Resource Engineering when appropriate. Whether a student seeks a broadly based program or wants to stress one area of specialization within the School, there is sufficient flexibility in the program elements to provide for a wide variety of career directions. Examples could include aspects of site evaluation and enhancement, unit and system design, production and processing, qualitative and quantitative measurement and computation. The specializations noted for each member of the graduate faculty within the three departments give further indications of the wide-ranging possibilities offered through graduate study in the School of Environmental and Resource Engineering.

Forest Engineering

TULLY, *Chairman* (Structures, Water Resources, Soil Mechanics); BENDER (Geodesy, Photogrammetry, Land Data Systems); BROCK (Analytical and Interpretive Photogrammetry, Remote Sensing); LEE (Systems Engineering, Computers, Soil Mechanics); LILLESAND (Remote Sensing, Environmental Monitoring and Transportation); PALMER (Harvesting, Systems Engineering)

Graduate study and research in the forest engineering department is primarily concerned with engineering analysis and design in concert with other pertinent disciplines for the inventorying and the holistic development of natural resources, with emphasis on those associated with the forest environment. The department's objective is to produce graduates with sufficient understanding of the forest environment and its resources, of the methodologies of scientific research and of the principles of engineering analysis or design to work with competence in resource-related research, engineering design and management.

Individually designed programs leading to the master of science and doctor of philosophy degrees are available. Undergraduate backgrounds required depend upon the student's needs and interests in graduate study. The student may emphasize engineering measurements, analysis or design within the department's breadth of engineering concern for environmental influences and resource utilization. Successful programs of graduate study in forest engineering may be efficiently designed by students with bachelor of science degrees in engineering or in forestry, natural sciences, physics or mathematics.

Programs of emphasis on environmental engineering measurements may be designed in remote sensing, photo interpretation, geodetic engineering, analytical photogrammetry and photogrammetric systems. Programs emphasizing engineering analysis and design are available in water resource, transportation, harvesting and site engineering systems. Included are the monitoring, measurement and evaluation of physical parameters affecting water, soil, timber, vegetation and wildlife.

Support for graduate study and research in the forest engineering department is both internal and external. The internal support includes modern laboratory and instrumentation facilities in the Engineering

Schools at both ESF and at Syracuse University. Exceptional departmental support exists for programs in environmental engineering measurements in the form of remote sensing and photogrammetric laboratories and the extensive forest properties owned by the College at which research may be conducted.

External support comes from several active sources, including industrial, commercial and governmental. Over the past two decades, close cooperation has developed special study and research opportunities with these sources.

Paper Science and Engineering

LEOPOLD, *Chairman* (Organic Chemistry and Mechanical Properties of Fibers and Paper); BAMBACHT (Pulping, Papermaking, Water Quality); DENCE (Organic Chemistry and Lignin Reactions); GORBATSEVICH (Pulping, Bleaching, Paper Technology and Paper Properties); JELINEK (Computer Applications, Process Engineering, Corrosion); LUNER (Mechanical and Surface Properties of Fibers, Films and Paper); MARK (Fiber Physics); MARTON (Paper Properties, Microscopy and Pulping); STENUF (Chemical Engineering, Instrumentation, Thermodynamics, Process Control, Metallurgy and Corrosion); TURAI (Water and Air Pollution Engineering, Materials Science and Engineering)

Outstanding for its vigorous growth and diversity of products, the pulp and paper industry is the fifth largest in the nation and exceptionally strong worldwide. The need for professional men and women with advanced education in science, engineering and technology is increasing even more rapidly than the industry itself. The College pioneered in providing graduate study in this area in 1920 with the organization of the paper science and engineering department, which has maintained a singularly high position in professional education for the continuing development of the pulp, paper and allied industries. Its graduates, who are in constant demand, occupy positions of leadership throughout the world.

Graduate studies reflect the strong trend toward diversification in the industry and offer opportunities for obtaining master of science and doctor of philosophy degrees in a variety of subjects related to the manufacture of pulp and paper. Individual study programs are designed to meet specific personal needs. Typical areas of study range from the development of new pulping processes, chemical interactions on the paper machine and the disposal of pulping and papermaking effluents, to the fluid dynamics of fiber suspensions, the colloidal chemistry of papermaking constituents and the physical properties of fiber networks.

Walters Hall, opened in 1969, is devoted exclusively to education and research in the field of pulp and paper. Containing a large number of special purpose laboratories and highly sophisticated equipment, it houses one of the outstanding research facilities in the world, the Empire State Paper Research Institute (ESPRI), an integral part of the department.

The department maintains an experimental pulp and paper mill equipped with machinery and instrumentation for studies of pulping, pulp purification, reuse of secondary fibers, refining, paper additives and papermaking. This facility includes a 42 inch fourdrinier paper machine, a 400-horsepower double-disk refiner, a two-pocket grinder for mechanical pulping and auxiliary equipment. Also included is a modern chemical engineering laboratory, designed for studies in all phases of unit operations and processes, process control and analog simulation.

Research activities aim to generate new information regarding the fundamentals, the science, the engineering and the technology of the papermaking process, utilizing advanced techniques such as electron microscopy, specialized spectrophotometry, nuclear magnetic and electron spin resonance and nuclear tracer methods. Recent work has been directed to fundamental investigations of pulping, bleaching, additives, paper recycling, effluent disposal, the papermaking process, the properties of paper, reactions of wood components during mechanical and chemical treatments, the structure of wood and wood fibers, evaporation, fluid dynamics, heat transfer and chemical recovery.

The department enjoys excellent external support in the form of graduate fellowships and grants from ESPRI and other industry sources, as well as a number of government granting agencies.

Wood Products Engineering

DAVIDSON, *Chairman* (Physical Properties of Wood); CÔTÉ (Cellular Ultrastructure, Light and Electron Microscopy); DeZEEUW (Wood Anatomy, Structure-Property Relations); KYANKA (Applied Mechanics, Structures); MEYER (Wood-Polymer Systems, Radio-Isotope Techniques); MOORE (Bonded Materials Technology); SIAU (Protective Treatments, Transport Processes); G. SMITH (Materials Marketing); L. SMITH (Polymeric Adhesives and Coatings)

While wood is one of the oldest structural materials known to man, its economic importance today is reflected in the fact that the annual tonnage of wood produced in the United States far exceeds that of any of the other major structural materials. This fact becomes even more important in this age of environmental and ecological concern because wood is the only major structural material that comes from a renewable natural resource, and demand is growing for more efficient utilization of available material. Improved efficiency must be based on solid scientific and engineering information. Thus research projects aimed at providing such information form the basis of graduate study in wood products engineering. The major areas of specialization are: wood science, timber engineering and product distribution systems.

Basic degree requirements for either a master of science or a doctor of philosophy degree include appropriate course work, which prepares the student to undertake a research project culminating in the writing of a thesis.

Recent research projects in wood ultrastructure have dealt with the interaction of coatings and glues with the wood substrate, cell wall development, the effectiveness of wood preservatives and the identification of natural inclusions in wood. The field of wood physics has had active projects in the permeability of wood, the mechanisms of fluid transport and the mechanisms of electric charge transport. Current projects are underway in the mechanical behavior of fiber networks, fracture mechanics of wood and the behavior of new structural designs which represent interests in the field of mechanics. In addition, there is a newly emerging field dealing with the properties of wood-based composite materials.

Laboratory facilities include a modern mechanics laboratory which has a range of mechanical testing machines, a well-equipped physics laboratory with various electronic instrumentation, and complete wood processing facilities including a sawmill and veneer mill. An extensive foreign wood collection provides the basis for the Tropical Timber Information Center (TTIC).

In addition, the College has available a complete microscopy laboratory, containing both scanning and transmission electron microscopes and a wide variety of light microscopes and related equipment. Extensive equipment for chemical analysis and nuclear chemical techniques serve the College's research program.

SCHOOL OF ENVIRONMENTAL AND RESOURCE MANAGEMENT

CHARLES C. LARSON, *Dean* (Resource Policy and Administration, International Forestry)

Department of Managerial Science and Policy

DALL, *Chairman* (Environmental Policy and Law); ARMSTRONG (Industrial Economics, Resource and Market Analysis); BENNETT (Economic Theory, Economic Thought in Forestry); CANHAM (Regional Economics and Planning); CHRISTIANSEN (Forest Productions Economics, Economic Systems Analysis); CUNIA (Operations Research, Statistics, Mensuration); GRATZER (Forest Recreation, Resource Management); GRAVES (Resource Policy, Planning, Management); HANSELMAN (Educational Communications); HENNIGAN (Resource Policy, Management); KOTEN (Management, Systems Analysis); MORRISON (Sociology of Outdoor Recreation); PETRICEKS (Macroeconomics, International Forestry Economics); STITELER (Biometry, Experimental Design, Computer Analysis)

Department of Silviculture and Forest Influences

BERGLUND *Chairman* (Silvics); BLACK (Watershed Management); CRAUL (Forest Soil Science); ESCHNER (Forest Influences); HERRINGTON (Meteorology); LEA (Silviculture); LEAF (Forest Soil Science); RICHARDS (Silviculture, Urban Forestry); WESTFALL (Physiology-genetics, Tree Improvement)

Adjunct Faculty

ECHELBERGER (Forest Recreation Research); HEISLER (Meteorology); WAGAR (Forest Recreation Research)

The School of Environmental and Resource Management is charged with responsibility for providing quality professional education in natural resource management, with particular emphasis on the resources of forest and associated open lands and their environmental influences, and with the conduct of strong programs of related research and public service. In accord with this broad mission, the School provides formal instruction at both the undergraduate and graduate levels and leading to the Bachelor of Science, Master of Science and Doctor of Philosophy degrees. Its undergraduate curriculum in environmental and resource management meets the accreditation requirements of the forestry profession as set forth by the Society of American Foresters. The basic objective of this program is to prepare students for the critical role of evaluating alternate goals in forest and associated land use, of recommending optimum approaches to the realization of these goals, and of working effectively with landowners, resource users and the general public in the formulation and implementation of resource policies and programs in the best interests of all concerned.

Graduate education in the School of Environmental and Resource Management builds upon the basic foundation of professional knowledge acquired by students in its undergraduate curriculum or in similar or closely allied programs of study. Instruction at this level is designed to prepare students for careers in resource administration, professional education and research, and a variety of other specialized positions in public and private employment bearing directly or indirectly on natural resources and environmental management. As shown in the figure below, the School offers advanced study opportunities under two broad degree programs: Resource Management and Policy and Silviculture and Forest Influences. In addition, its faculty contribute significantly to several College-wide graduate programs and joint areas of advanced study, including fish and wildlife managerial science, water resources, environmental planning, environmental science, and soils science.

Several areas of specialization are available within the two degree programs, as shown. Opportunity is also provided for students, in consultation with faculty advisors, to arrange areas of study specific to their interests and needs which integrate elements of two or more areas of specialization, as in the case of world forestry. Whatever the program, the basic purpose is to help the student acquire the tools and facility for disciplined, logical, critical, constructive and creative thinking, and for clear expression in the selected field.

Prospective students who desire more information than is presented for each of the graduate programs and specialties described below should contact the Dean, School of Environmental and Resource Management.

Resource Management and Policy

Today's successful resource manager is one who can anticipate and prevent environmental troubles as well as attempt to remedy them;

SCHOOL OF ENVIRONMENTAL
and
RESOURCE MANAGEMENT

GRADUATE PROGRAMS
and
Areas of Specialization

RESOURCE MANAGEMENT AND POLICY	SILVICULTURE
Forest Management	Silvics
Recreation Management	Silviculture
Policy and Administration	Forest Soil Science
Forestry Economics	Tree Improvement
Quantitative Methods	Forest Influences
Land Use Planning	
Environmental Communications	

World Forestry

who is equipped not only to make current institutions function effectively but also to create new ones better fitted to changing social needs; and who can bring the strengths of many disciplines to bear on vexing environmental problems.

The graduate program in Resource Management and Policy is designed to meet the needs of students for broad theoretical education and training in techniques for application in a variety of resource conservation fields. The program is administered by the Department of Managerial Science and Policy of the School of Environmental and Resource Management. The department offers instruction in social sciences, law, management, administration and quantitative methods for its own as well as in service to other programs of the College.

Students have options to emphasize studies in applied fields but each individual must make selections, with faculty approval, to comprise a meaningful, coherent, interdisciplinary study plan. Applied fields are described below and include forest management, forestry economics, policy and administration, environmental communications, land use planning, quantitative methods, and recreation management. Typically, the study plan is designed by an individual in consultation with a major professor and other members of the faculty as the case may require. The criteria used include the student's undergraduate preparation, his study and career objectives and our institutional capabilities. Courses are selected from the departmental offerings, the offerings of other departments of the College (described in this catalog) and those of Syracuse University.

Master's Degree Program

The entering student is expected to have a body of knowledge obtained through undergraduate study which includes biological, physical and social sciences. Graduates from such programs as forestry, agriculture, wildlife management, watershed management, or liberal arts with a sufficient background in the sciences should qualify. In a number of cases, students will have to make up for the lack of required knowledge by taking undergraduate courses.

During the first year, all students in the program are required to take four core courses, in order to obtain a minimal base for becoming qualified for professional service in resource management and policy. These four courses are:

RMP 601 - Resource Management Systems
RMP 602 - Resource Economics
RMP 603 - Research Methods in Resource Management and Policy
RMP 753 - Resources Policy

The remaining course work will be built around such subdivisions of the program as forest management, quantitative methods, land use planning, recreation management, policy and administration, and forestry (resource) economics.

A thesis is also required. The approach to thesis writing may be based on collection and interpretation of primary data, or emphasis may be placed on reading and secondary data, thus acquiring additional knowledge in an area of resource management and policy, chosen by the student for its special interest to him.

The total credit requirement is 30, including the thesis. The normal time for completing these requirements is three semesters.

Ph.D. Degree Program

Requirements for the doctorate usually build upon a master's degree, and demand a substantial mastery of material related to the dissertation topic. At the same time, a number of other fields are chosen to support or integrate the selected central topic of doctoral study. There is no minimum credit requirement, but the normal course workload is 30 credits, and the field work for and the writing of a dissertation usually requires a minimum of 12 months. The topics for a doctoral dissertation would typically fall within one of the areas mentioned for master's study, namely forest management, quantitative methods, land use planning, recreation management, policy and administration, and economics.

The additional requirements for a doctoral program, beyond a master's degree, is a residence of two continuous semesters, passing of written and oral comprehensive examination which is intended to test the student's integration of subject matter, and the writing and successful defense of a dissertation.

Forest Management

The forest management area focuses on the planning and implementation processes necessary to achieve integrated use of forests and related resources. The objective is to develop expertise sufficient for capable, professional resource management to satisfy a wide range of societal needs.

Broad knowledge of the operation of both biological and social systems is combined with skill in the use of managerial tools. Concepts in decision theory, and information and organization theory, particularly, are applied to representative cases at varying levels of complexity. Syracuse University's School of Management and Maxwell Graduate School of Citizenship and Public Affairs offer a broad array of support courses. Students prepare themselves for any of a wide range of positions in research, program analysis, teaching, administration, budgeting and other phases of forest resource management with federal and state agencies and private firms.

Recreation Management

Graduate study in this area equips students with broad understanding of the nature and purposes of outdoor recreation and how it relates to natural resources, and builds the skills necessary for capable recreation management.

Individual programs combine study in resources management with relevant studies in the social sciences and development of analytical and political capabilities needed to implement plans and programs. The U.S. Forest Service Research Unit, situated on campus, provides strong support for research and independent study. Other schools of the College and of Syracuse University, treating such areas as planning, engineering, design and education, provide a wide range of supporting courses and facilities.

Policy and Administration

Graduate study in the area of policy and administration prepares students for the broad range of responsibilities comprising the field of program administration in a public agency or a business at the executive, planning, budgeting, programming or operating levels. Advanced courses, special problems and seminars structured around man-resources relationships, resources policy issues, administrative management, and environmental law are offered.

Students are encouraged to round out their academic programs through the offerings of other units of the College as well as the Syracuse University Maxwell Graduate School of Citizenship and Public Affairs and the School of Management.

The wide-ranging possibilities of course selection and the differing points of view that are available allow the student to tailor a program to meet specific career objectives. This breadth and diversity also offers the student an opportunity to develop talents for top executive leadership in various aspects of a field that is critical to the future of resource management.

Forestry Economics

In this area, study at the master's level is designed to meet the needs of the graduate in forestry or forest products. It also serves the graduate in liberal arts, engineering or business whose interests point toward the economics of forest resource management. The aim is primarily to broaden the student's understanding of the content of forestry economics.

The Ph.D. program is for those who wish to make a career as professional forestry economists in research institutions, in the academic world, or in business or government. The goals are depth of understanding and familiarity with economic tools contributory to making competent decisions in resource economics, management and policy. Requirements are generally the same as those observed in economics departments of leading universities, except that the student completes specified work in the economics of forestry.

Individual programs may include supporting courses in general economics, mathematics and statistics, operations research, business, international affairs and other social sciences and related fields. The broad array of course offerings and substantial library resources, computer facilities and other resources of Syracuse University supplement those of the College.

Quantitative Methods

Study in the area of quantitative methods is designed to develop professionals skilled in mathematical and statistical problem solution and equipped to act as biometricians, mensurationists or in similar posts, with state and federal agencies and with private firms.

The program is designed primarily for students who have done their undergraduate work in areas such as biological sciences, forestry, wildlife or agriculture. Others, who lack background courses, may take this material concurrently. Students may concentrate in statistics, operations research, biometry, or forest mensuration. Syracuse University's IBM 370 computer, programming banks and a wide range of courses in mathematics, statistics and quantitative methods give strong support to the program.

Land Use Planning

Graduate study in land use planning aims to show how development and utilization of the land resource affects and is affected by natural and social systems. It provides basic understanding of the tools and processes of regional planning and addresses land use policy issues. Student programs are flexible and draw heavily from course offerings in resource economics, resource policy and administration, open space planning, and applied ecology. In addition, the rich course offerings of other Schools and Syracuse University in such areas as remote sensing, geography and metropolitan studies are available. Some undergraduate work in the natural and social sciences is required.

Employers normally include county, regional and state planning commissions; federal agencies such as the Forest Service; and private consulting firms. Consultation from these sources is encouraged in graduate theses and research, and in the conduct of seminars.

Graduates find employment in resource management agencies administering recreation areas; in national, state and local parks and recreation departments; in educational institutions and in private organizations involved in recreation.

Environmental Communications

This area of study prepares specialists to interpret effectively, for a wide range of publics, biological, ecological and socioeconomic events relating to natural resource management and use and the protection and enhancement of environmental quality. Understanding of the operation of natural resource systems and of social and managerial systems is combined with expertise in education and in the tools of communication, including print, nonprint and other instructional technologies, to develop skill in analyzing and interpreting resource and environmental affairs.

Individual study programs draw heavily upon instructional resources not only within the School of Environmental and Resource Management, but also in other schools of the College and Syracuse University, especially the latter's Newhouse School of Public Communications. Independent studies, special projects and internships are often a major component of study programs.

The breadth of study options allows students to orient their career goals within a wide range of employment possibilities. Graduates find employment with resource management agencies, industrial firms and associations, community environmental education centers, private environmental organizations, conservation associations, professional societies, post-secondary educational institutions, and the mass media.

Those who aspire to study in this program area must possess or be prepared to acquire the necessary background for graduate candidacy in resource management and policy. Students who do not have such background or whose career objectives are not commensurate with resource management will be encouraged to pursue their environmental communication interests through the graduate program in Advanced Environmental Science described elsewhere in this catalog.

Silviculture and Forest Influences

Concern for the forest ecosystem provides a major focus for graduate study in the Silviculture and Forest Influences Program, with this ecosystem viewed in its role as a producer of goods and services and as a modifier of the physical environment in which man lives. It is in this context that translation of these concerns to broader questions of environmental quality is emphasized.

Silviculture in its functional sense is the bridge between fundamental biological and physical relationships and the applications of these relationships in the forest environment. Thus, graduate study in the many aspects of silviculture can cover a broad spectrum of disciplines, and can be as basic or as applied as the objectives of the student indicate. Individual study programs are coordinated with various areas of specialization both within the Department of Silviculture and Forest Influences and with other departments of the College and of State University of New York, and, as well, with Syracuse University. A major strength is the close association of scientists representing a wide range of specialties, and both formal and informal cooperative arrangements between these scientists and their counterparts in federal and state agencies and in industry.

Physical facilities that are routinely used in graduate study within the Silviculture Program include well-equipped laboratories, specialized equipment, and greenhouse facilities; and extensive College forests of nearly 25,000 acres on which are located natural and planted stands, seed orchards, a forest tree nursery, and two large micro-climate tower complexes with associated automated data acquisition systems and instrumentation. Major field installations include long-term northern hardwood stand improvement studies and the oldest continuous forest fertilization studies in the United States.

Included within the Silviculture Program are five fields of specialization that, singly or in combination, provide the graduate student with a wide array of course work, research activities, and faculty guidance all aimed at enhancing his understanding of the forest ecosystem. These specializations are silvics, silviculture, forest soil science, tree improvement and forest influences.

Silvics

Silvics is often defined as that branch of forestry which provides the scientific base for the cultural treatment of forest vegetation by (1) defining interrelationships within forest ecosystems and (2) cataloging general intraspecific characteristics of tree species. In a sense, silvics is the ecology of managed forest ecosystems, although unmanaged and natural forests are often studied intensively because they provide the benchmark conditions from which the silviculturalist begins.

The specialist in silvics must maintain channels of communication with his colleagues in the basic disciplines, including those in soil physics, soil chemistry, micro-meteorology and climatology, genetics and tree breeding, plant physiology, wildlife biology, entomology, and pathology.

In addition, certain tools, including a comprehensive knowledge of probability and statistics, the ability to use modern computers effectively, and a familiarity with measurement and sampling theory, are required by specialists in most applied sciences including silvics.

The specialist in silvics is essentially at one focal point of much of what has been called fundamental forest research. His most useful function and worthwhile contribution to the field of forestry may very well depend on his ability to synthesize relevant material and, through experimentation, provide the silviculturist with information and possibly techniques for use in the cultural treatment of forest vegetation.

Silviculture

Classical silviculture can be defined as the theory and practice of the manipulation of forest ecosystems, including the control of vegetation establishment, composition, growth, and quality. The nature of cultural treatments, the theories upon which they are based, and the biological, physical, and social constraints to their implementation are stressed in this area of specialization. Elements of forest vegetation are intensively examined from the dual standpoints of fulfilling management goals for goods and services while maintaining or enhancing biotic productivity for the future.

Management goals are considered to include all the many and varied goods and services that the basic forest resource is capable of supplying. Forest productivity is of basic concern; the student specializing in this area progresses through formal course work and research toward an understanding of the effect of various treatments on the continuous, balanced, and adequate supplies of wood, water, wildlife, recreation opportunities, and amenity values. While major emphasis relates to treatment of tree stands for their continued production of wood products, increasing attention is directed to the cultural practices important for primarily noncommodity forest values.

The Silviculture graduate specialization is aimed at preparing foresters to understand and evaluate forest ecosystems in whatever depth may be required, and to prescribe treatments or further experimentation to attain management objectives or increase knowledge toward this end.

Forest Soil Science

Graduate studies in this area of specialization may be directed toward aspects of soil science related to the quantity and/or quality of goods and services in the management of resources of nonagricultural lands, and the impact of management practices on environmental quality. These include soil moisture, soil temperature, and nutrient element status interrelationships in the evaluation of soil productivity; evaluation of ecosystems to quantify nutrient element balances and cycling; amelioration of soils for increased productivity; and impact of various land-use practices on soil productivity.

Modern well-equipped laboratories are available for graduate student use in plant, soil, and water chemical analyses; soil water-holding capacity and compaction; infiltration and runoff; and other chemical and physical property investigations. The extensive College properties noted previously permit forest soil research to be conducted under a wide variety of environments and ecological conditions.

Programs are coordinated with other areas of specialization through cooperation among Department personnel, with other departments of the College, Syracuse University, and the U.S. Forest Service.

Tree Improvement

Graduate study in tree improvement is designed to educate highly competent people at the master's and doctoral levels and to derive new concepts in applied forest genetics. A broad spectrum of basic and advanced courses are available at the College and at Syracuse University.

In his thesis research, the student has the flexibility and opportunity to pursue varied research interests as well as contribute to long-term basic problems. Current active and potential research problems include the genetics of wood quality, ozone resistance in eastern white pine, the genetics of pest-host relationships, the biology of monoterpenes and resin acids in forest trees, and genecological variation in forest trees. Graduates are qualified to fill a variety of positions in research, or tree improvement operations.

Forest Influences

Forest Influences as an area of graduate study includes all the effects resulting from the presence of forest trees and associated vegetation on climate, the hydrologic cycle, erosion, floods, and soil productivity. Health considerations and human comfort have often been included in older definitions of forest influences, and are assuming greater importance today with our growing concern for the environment.

Included among the principal studies in this area are energy exchange between forest and atmosphere; moderation of urban environments by vegetation; soil and slope stability; and watershed hydrology, including snow.

Graduates fill a variety of positions in research, teaching, and public and private managements, as watershed management specialists, hydrologists, environmental officers, meteorologists and ecologists.

World Forestry

Graduate education in world forestry as an area of emphasis is available to students under both the Resource Management and Policy and Silviculture and Forest Influences programs and is designed to assist individuals who are intent upon pursuing internationally-oriented careers in forestry and related fields.

Instruction is aimed at supplementing and enriching the student's technical forestry knowledge and providing the broad background deemed necessary for effective service as forestry advisor, teacher, or research specialist with national and international agencies, private business and industrial firms, philanthropic foundations and voluntary service organizations whose activities include the development and use of forest resources in other lands.

At the master's level, program emphasis is on the attainment of general competence in research methods, foreign languages, cultural anthropology, world geography, and international affairs, plus a broad understanding of the world forestry situation. At the doctoral level, program concentration is on a specialized discipline area such as forestry economics, forest policy and administration, forest management or silviculture. Orientation to the world forestry field is achieved in part through the selection of formal course work, and in part through providing an opportunity for the student to conduct his thesis research in residence abroad.

A wide variety of course offerings are available to support the non-forestry elements of this area of study through Syracuse University. Opportunity for field training and research in tropical forestry and related fields is available to qualified candidates, especially at the doctoral level, under cooperative agreements maintained by the College with the Institute of Tropical Forestry in Puerto Rico and the University of the Andes, Merida, Venezuela.

SCHOOL OF LANDSCAPE ARCHITECTURE

ROBERT G. REIMANN *Dean* (Methods and Philosophy of Design)

CURRY (Urban Analysis and Design); EARLE (Art and Design, History of Environmental Development); FELLEMAN (Site Engineering, Resource Policy Administration); FREEMAN (Plant Materials, Site Design); HARPER (Regional Environmental Planning); HIBBARD (Site Design); LEWIS (Community Planning, Systems Dynamics, Gaming Simulation); NIEMAN (Regional Planning and Environmental Impact); PAULO (Design, Environmental Law); POLLAK (Social Policy Planning and Analysis, Social Geography); WARBACH (Graphics and Design)

Landscape Architecture

There has always been a need and a desire for man to adjust to his physical environment, or to modify it in order to meet his requirements for shelter, sustenance and communication. Society has reached the point in the latter half of the 20th century where economic and technological sophistication enables man to completely control the physical environment. It is within the balance between man and nature, and the manipulation of land as it relates to man's use, that the role of the landscape architect lies. The professional landscape architect is concerned with the visual quality and form of the physical/cultural landscape. Because of this concern, the landscape architect may work at any scale, from the design of small site projects with their related designed amenities, to the orchestration of regional, national or international projects which attempt to develop policy for qualitative use of land.

Landscape architecture is a profession concerned with the interrelationship of people and land. The dynamics of this relationship have lead to a professional commitment to meet changing societal needs.

The MLA degree program offers the opportunity to study advanced concepts and methods in landscape architecture. It is normally completed in two years. The curriculum has three components: a sequence of required core courses; a series of elected courses; and a thesis/project.

Studio workshop courses, seminars and courses in methods of environmental research form the required core sequence. Emphasis in these courses is given to identification and articulation of environmental problems, development of strategies for their solution and utilization of sophisticated methods and techniques in their resolution.

Complementing the required courses, the degree candidate takes a series of elective courses normally chosen from the School, the College of Environmental Science and Forestry or Syracuse University. Each student orients the choice of elected courses according to personal educational objectives. The student may wish, for example, to specialize in one or generalize in the many disciplines related to the needs of the professional landscape architect. Upon approval by the faculty, a student also has the opportunity to take part of the elected course work in self described independent study.

Each MLA candidate completes the degree requirements by preparing a well-documented thesis/project and satisfactorily defending the work in an oral examination. The thesis/project is normally completed during the fourth semester of residence.

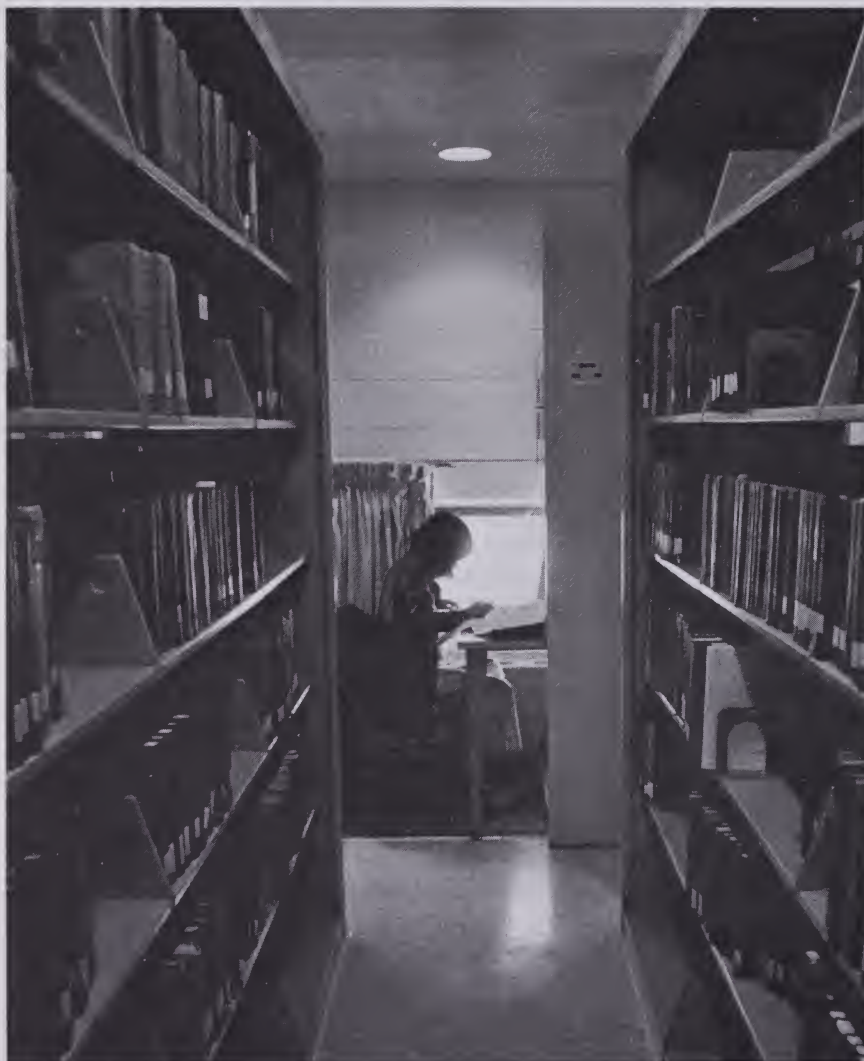
Research at the School, both sponsored and independent, has two major thrusts. The first is applied research emphasizing development of greater sophistication in utilizing advanced methodologies in solving landscape architectural problems. The second is original research emphasizing development of new criteria, methods, and techniques which expand the realm of professional knowledge.

The College library and the several libraries on the Syracuse University campus offer reference material to support study programs. Facilities at the School are extensive. They include adequate studio and office space as well as reproduction, model making, photographic and audio-visual equipment. The College maintains a computer center which is used primarily for instruction and is available for individual use by graduate students. The College also has a fully equipped video tape recording (VTR) studio and photogrammetric labs.

The School is unique in its location within the College of Environmental Science and Forestry. This situation provides the MLA candidate with the opportunity to draw upon information and knowledge in ecology, natural sciences, resource management, forestry and many other related environmental disciplines. In addition, the relationship with Syracuse University provides the School with an extensive intellectual as well as physical resource basis.

The Syracuse area has the largest concentration of landscape architectural firms in the State, outside of New York City. With a metropolitan population of nearly 500,000, the city has many opportunities for urban-oriented study. Also, the city's central location in upstate New York provides easy access to a rich variety of public lands and recreation areas which are planned and administered by a diverse range of governmental agencies and private owners.

Any student with a bachelor's degree, or the equivalent from a college or university of recognized standing, is welcome to apply for admission to the MLA degree program. Along with the general application requirements of the College, each applicant is urged to submit any examples of work, such as academic reports, terminal projects and portfolios of creative endeavors or design work.



Course Offerings

Graduate students at the College of Environmental Science and Forestry have not only the academic and research resources of their own institution, but also the resources of nearby Syracuse University and State University Upstate Medical Center.

In graduate programs at the College, Syracuse University courses are used extensively in the fields of mathematics, physics, chemistry, biology, engineering, economics, business and citizenship. The State University Upstate Medical Center has courses available for graduate programs in the areas of anatomy, biochemistry, cytology, microbiology and physiology.

COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY COURSE DESCRIPTIONS

The courses offered by the College are grouped by general subject areas, and the number of credit hours appears after the course title. A credit hour means one recitation (or lecture) hour per week. Three laboratory hours are equivalent to one lecture hour.

Course Numbering System

Code Levels:

500-599 Graduate Courses designed expressly for graduate students, in areas supporting their specialization or interdisciplinary program, or for fifth year professional students with baccalaureate degrees (e.g., BLA students with B.S. in Environmental Studies), and available for undergraduate credit by selected upper division undergraduate students with superior academic records.

600-699 Graduate courses designed for beginning graduate students. Undergraduates are permitted admission only by petition with a well-documented justification approved by the undergraduate advisor and curriculum director and the instructor of the course.

700-899 Advanced graduate courses designed primarily for second and third year graduates and beyond, but available to all graduates.

900-999 Special graduate courses available only to doctoral students.

APPLIED MATHEMATICS (APM)

500. Introduction to Computer Programming for Graduate Students **(3)**
This basic course in computer use offered by the College is intended to provide the student with the skill and understanding needed to utilize digital computer languages for problem solving. The course includes a rather detailed study of Fortran IV, plus some discussion of an Assembly language and moderate study of Cobol and APL. To provide completeness, some attention is also afforded to techniques of representing information, managing files, error control and to operating systems and job control. This course or a demonstrated equivalent is a prerequisite to individual student use of the College computer facilities. Fall and Spring.

605. Theory of Probability Distributions **(1-3)**
Three hours of weekly sessions over 5-14 weeks. Statistical problems and mathematical models; random experiments, random variables, probability, frequency and distribution functions of discrete, continuous and mixed random variables; functions of random variables and the probability distributions; mathematical expectation and its applications; discussion of the main theoretical distributions such as binomial, Poisson, negative binomial, normal, Gamma, Beta, exponential and others; applications of this framework to the model construction problem in the statistical, operations research and forest mensuration areas. Fall or Spring. Mr. Cunia.
Prerequisites: Two semesters of differential and integral calculus and an introductory course in statistics, or permission of the instructor. The course can be taken in conjunction with APM 651—Operations Research I (for 1 credit hour) or independent of it for 1 to 3 credit hours.

610. Statistical Analysis **(3)**
Two hours of lecture and 3 hours of lab. A treatment of statistical inference, including paired design, group design, linear regression and correlation, one way analysis of variance and some applications of chi-square. Calculation of statistics, tests of hypotheses and proper interpretation of calculated statistics. Fall. Staff.

620. Analysis of Variance **(4)**
Three hours of lecture and recitation and 3 hours of lab. Multiway classifications in the analysis of variance, with emphasis on the development of models, including randomized blocks, latin squares, split plots, and factorial designs with fixed effects, random effects, and mixed effects; multiple and partial regression and correlation (including curvilinear), using matrix methods; analysis of covariance, higher order contingency tables, distribution free methods, and sequential testing. Fall or Spring.
Prerequisite: Graduate standing and an introductory course in statistics covering material through the one-way analysis of variance.

625. Introduction to Sampling Techniques **(3)**
Two hours of lecture and 3 hours of lab. Introduction to the scientific basis of sampling: selecting an appropriate sampling unit; choosing an efficient design; calculating sampling error; determining a sample size to meet stated objectives. Spring. Staff.
Prerequisite: APM 491 or equivalent.

630. Regression Techniques with Applications to Forestry **(3)**
Two 1½ hours of lecture per week. Review of matrix algebra, probability theory and statistical methods. Basic concepts in regression analysis. Classical linear regression model. Least and weighted least squares method. Dummy variables and their uses in regression and covariance analysis. Applications to problems of statistical prediction and estimation from the field of forestry in general and forest mensuration and inventory in particular Fall. Mr. Cunia.
Prerequisites: APM 491 or equivalent.

635. Multivariate Statistical Methods **(3)**
Estimation and inference for the multivariate normal distribution. Multivariate analysis of variances, factor analysis, principal components analysis, canonical correlation, discriminant analysis, cluster analysis. Spring. Mr. Stiteler.
Prerequisite: One semester of statistics.

651. Operations Research I **(3)**
Two 1½ hours of lecture. Stochastic OR models applicable to managerial process or systems analysis. Elements of probability theory, theory of games and decision theory, queuing model, simulation techniques with applications to queuing and inventory problems, and, if time permits, Markov chains. Fall. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

652. Operations Research II **(3)**
Two 1½ hours of lecture. Deterministic OR models applicable to managerial problems or systems analysis. Elements of Matrix Algebra, solving simultaneous linear equations, mathematical programming, classical optimization techniques, Lagrange multipliers. Linear programming transportation and allocation models, dynamic programming, network analysis and, if time permits, quadratic, parametric and integer programming. Spring. Mr. Cunia.
Prerequisites: APM 491 and MAT 227 or equivalent.

660. Information Processing Fundamentals **(3)**
The course presents problem solving and analytical structures, and practice in their application by use of a digital computer. Selected portions from the two general processing categories of numerical analysis and information systems are presented for discussion and study. The purpose is to develop an awareness with some understanding and proficiency in automated problem-solving systems. Spring.
Prerequisite: Integral calculus and proficiency in computer programming.

760. Computer Applications **(3)**
A course presenting some discussion and practice in the application of computers to the solution of complex large-scale problems. A study of simulation techniques provides the opportunity to apply a computer to the solution of problems normally considered outside the realm of classroom experience. A study of some programming systems permits the opportunity to see how computers are used to solve their own problems of efficiency concerned with time, space and reliability. Spring. Mr. Lee.
Prerequisites: APM 460 and APM 491 or the equivalents.

ENVIRONMENTAL SCIENCE (ENS)

797. Environmental Science Seminar **(2)**
Discussion of current topics and research related to environmental science. Fall and Spring.

798. Problems in Environmental Science **(Credit hours to be arranged)**
Specialized study in the problem areas of Environmental Science for graduate students. Tutorial conferences, discussions, seminars, workshops, and critiques scheduled as necessary. Comprehensive report required for some subjects. Fall and Spring.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring.

ENVIRONMENTAL AND RESOURCE ENGINEERING (ERE)

563. Photogrammetry I **(3)**
Two hours of lecture and discussion, 3 hours of laboratory and discussion. Basic photogrammetric and photo interpretation concepts as a means of acquiring reliable data for engineering and management planning. Potentials, limitations, instrumentation and unique requirements are considered. Fall and Spring. Mr. Brock.
Prerequisite: FEG 271 (or FEG 371 concurrent) or equivalent.

596. Special Topics **(1-3)**
Lectures, conferences, discussions and laboratory. Topics in environmental and resource engineering not covered in established courses. Designed for the beginning graduate student or selected upper division undergraduate. Fall and/or Spring. Staff.

640. Water Resource Systems **(3)**
Three hours of lecture and discussion per week. Fundamentals of the systems approach to complex water resource problems. Characteristics of water resource systems, related to systems engineering methodologies. Quantitative and qualitative subsystems are considered in a technical nature which exposes the socio-legal-political interfaces of water resource decisionmaking. Fall and/or Spring.
Prerequisite: FEB 340 or equivalent.

652. Remote Sensing Interpretation **(3)**
Two hours of lecture and 3 hours of laboratory per week. Introduction with a qualitative emphasis to the fundamentals of acquiring, analyzing and utilizing remote sensing data in the performance of natural resource inventories, environmental quality surveys, site development studies and land use analyses. Oriented for multidisciplinary participation. Fall and/or Spring. (Not open to students having previous credit for FEG 352.) Mr. Lillesand.
Prerequisite: Physics and calculus or consent of instructor.

655. Remote Sensing Measurements **(3)**
One hour of lecture, 1 hour of discussion and 3 hours of laboratory comprising an in-depth coverage of the theory, design and application of remote sensing systems and techniques employed to obtain precise spectroradiometric measurements in vegetation surveys, site engineering, data acquisition endeavors and environmental monitoring efforts. Photographic and nonphotographic systems are considered. A variety of field and laboratory measurement endeavors employing precision remote sensing equipment is included. Fall. Mr. Lillesand.
Prerequisite: FEG 352 or 652 and FEG 363 or 563 or consent of instructor.

658. Geometric Geodesy **(3)**
An introductory graduate level course for those without previous background in theoretical geodesy. Topics covered include position determination for short and long lines on the ellipsoid, the ellipsoidal triangle, the parametric equations, three-dimensional geodesy, and mappings of the ellipsoid. Fall. Mr. Bender.
Prerequisite: Permission of the instructor.

659. Astronomic and Gravimetric Geodesy **(3)**
An introductory graduate level course in geodetic astronomy and the gravity field of the earth. Topics covered include updating star positions; precise time keeping; position determination by natural and artificial satellites; the fundamental concepts of gravimetric geodesy, including the potential function; attraction; undulations of the geoid and deflections of the vertical. Fall. Mr. Bender.
Prerequisite: FEG 674.

660. Theory of Errors and Adjustments **(3)**
The theory of errors and adjustment of observations oriented toward geodesy and photogrammetry. Topics include error definitions, weighted observations, method of least

squares, matrix algebra in adjustments, variance-covariance matrix, the error ellipse and the general case of adjustment. Fall or Spring. Mr. Brock.
Prerequisite: Calculus; a beginning course in statistics.

664. Photogrammetry II **(3)**
Mathematical theory of photogrammetry including space resection, orientation and intersection. The theory and use of photogrammetric analogue computers in providing resource engineering maps. Fall. Mr. Brock.
Prerequisite: FEB 563 or equivalent.

671. Pulping Technology **(3)**
One hour of lecture and 6 hours of laboratory plus evaluation of literature, independent project planning and/or laboratory study. Discussion of pulping and bleaching processes. Effects of chemical and physical variables on the wood components and pulp properties; chemistry involved. Experiments in pulping and bleaching, and pulp evaluation. Fall. Mr. Gorbatsevich.
Prerequisites: PSE 370, CHE 346, and CHE 356.
Note: A student may not enroll in or receive credit for both PSE 461 and ERE 671.

677. Paper Properties **(4)**
Three hours of lecture, 3 hours of laboratory and discussion plus evaluation of literature, independent project planning and/or laboratory study. Evaluation and study of the physical, optical and chemical properties of paper and the inter-relationships existing between paper manufacturing methods, papermaking additives, test results and the ultimate properties desired in the finished paper. Fall. Mr. Bambacht.
Prerequisites: Consent of instructor.
Note: A student may not enroll in or receive credit for both PSE 465 and ERE 677.

678. Paper Coating and Converting **(3)**
Two hours of lecture and 3 hours of laboratory plus evaluation of literature, independent project planning, and/or laboratory study. Evaluation and study of the various coating materials and processes used by the paper industry. Introduction to polymers and their use in converting operations. Study of materials and equipment used in converting operations, fundamentals and parameters which control their use, effects on final properties of papers. Spring. Mr. Bambacht.
Prerequisites: PSE 465 or consent of instructor.
Note: A student may not enroll in or receive credit for both PSE 466 and ERE 678.

680. The Anatomy and Ultrastructure of Wood **(2)**
Two hours of lecture and/or demonstration and discussion. The gross, microscopic and submicroscopic structure of wood including organization of the cell wall, distribution of chemical constituents and abnormalities in wood. Fall. Mr. Côté and Mr. de Zeeuw.
Prerequisites: None.

682. Transport Processes **(3)**
Two hours of lecture and 3 hours of laboratory. The relationship between wood structure and wood permeability, moisture movement, and heat transfer. Fire retardant and wood-preservation treatments. Wood drying. Unsteady-state transport processes. An advanced laboratory problem with report in wood-moisture relationships, wood drying, the relationship between wood permeability and treatability, or wood preservative treatments. Spring. Mr. Siau.
Prerequisite: Permission of instructor.

684. Mechanical Properties of Wood **(3)**
Two hours of lecture and 3 hours of laboratory. The effect of the anatomical and chemical nature of wood on its response to static and dynamic force systems. The theory of elasticity as applied to wood. Fall. Mr. Davidson.
Prerequisite: Permission of instructor.

685. Applied Electron Microscopy (3)
Two hours of lecture and/or demonstration and 3 hours of laboratory. The theory and operation of the transmission electron microscope including specimen preparation, photographic technique and interpretation of micrographs. Fall. Mr. Côté.
Prerequisite: None. Consultation with instructor advised.

686. Wood-Water Relationships (3)
Two hours of lecture and 3 hours of laboratory. Relationship between wood moisture content and its environment, electrical properties, theories of moisture sorption, hygroscopic swelling and shrinking, thermodynamics of moisture sorption, mechanism of moisture movement. Fall. Staff.
Prerequisite: Consent of Instructor.

688. Tropical Timbers in Commerce (2)
Two hours of lecture. Introduction to the commercial use of tropical timbers; the factors of forest conditions, stand types and wood qualities influencing their utilization and the development of trade. Sources of information. Spring. Mr. de Zeeuw.
Prerequisite: Permission of instructor.

689. Tropical Wood Anatomy (1)
Anatomical characters, identification and taxonomy of tropical woods important in commerce. Mr. de Zeeuw.
Prerequisite: WPE 386 or 387. Recommended that WPE 688 be taken concurrently or previously.

760. Analytical Photogrammetry I (3)
Two hours of lecture and 3 hours of laboratory per week. Mathematical theory of photogrammetry including space resection, orientation, intersection and aerial triangulation. Fall. Mr. Brock.
Prerequisites: FEG 363 and APM 360 or equivalent.

762. Instrumental Photogrammetry I (3)
Two hours of lecture and 3 hours of laboratory. The theory and practice of extracting information from photographs with the aid of photogrammetric plotters. Fall. Mr. Brock.
Prerequisite: FEG 363 or equivalent.

775. Industrial Thermodynamics (3)
The study and application of thermodynamics, including the first and second law, phase relationships, thermochemistry, the production of work and equilibrium relationships. Fall. Mr. Stenuf. Course given in even calendar years.
Prerequisites: CHE 346, CHE 356, or equivalent.

796. Advanced Topics (1-3)
Lectures, conferences, discussions and laboratory. Advanced topics in forest engineering, paper science and engineering, and wood products engineering. Fall and/or Spring. Staff.
Prerequisite: Consent of instructor.

797. Seminar (1-3)
I. Forest engineering topics. II. Paper science and engineering topics. III. Wood products engineering topics. Fall and Spring. Staff.

798. Research in Environmental and Resource Engineering (Credit hours to be arranged)
I. Independent research topics in forest engineering. II. Independent research topics in paper science and engineering. III. Independent research topics in wood products engineering. Fall and Spring. Staff.

880. Interpretation of Cellular Ultrastructure **(2)**
One hour of lecture and 2 hours of demonstration and discussion. The organization and sculpturing of the walls of plant cells; the cellulose microfibril, matrix and incrusting substances, and the warty layer. The ultrastructure and general function of cytoplasmic organelles in cells. The tools and techniques used for light and electron microscopic study of cells, and the interpretation of structural evidence. Directed study and discussion of the latest (current) literature on pertinent topics. Spring. Mr. Côté.
Prerequisite: Permission of the instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

FOREST BIOLOGY (FBL)

540. Chemical Ecology **(3)**
Two hours of lecture and 1 hour of discussion. A treatment of biological phenomena incorporating elements of ecology, physiology and chemistry as a basis for development, behavior and survival. Emphasis is on the intra- and inter-specific relationships involving chemical messengers at the organismal, population and community levels. Spring. Mr. Simeone.
Prerequisites: Organic chemistry, general ecology, general physiology.

670. Cytogenetics **(3)**
Two hours of lecture and 1 hour of seminar and discussion. Structure and behavior of chromosomes in animals and plants are considered. The effects of chromosomal aberrations and abnormal chromosome numbers on somatic and germ cell divisions, on the physiology and development of organisms with emphasis on human diseases and on populations including structure, speciation and evolution are discussed. Lecture demonstrations include tissue culture and cell hybridization methods for karyo-type analyses and somatic cell genetics. Fall (odd calendar years). Messrs. Lanier, Valentine and Neu.
Prerequisite: FBL 370 or permission of the instructors.

785. Histochemical Techniques **(3)**
One lecture and two labs. The techniques of the microtomecryostat, freeze-drying and freeze substitution, histochemical stains, and autoradiography in the elucidation of the constitution of cells and tissues. Spring (even calendar years). Mr. Tepper.
Prerequisites: Microtechnique and organic chemistry.

796. Topics in Biology **(1-3)**
A course offered by the faculty for students interested in biology. Check the Schedule of Courses for details. Fall and Spring. Staff.

835. Membranes and Biological Transport **(3)**
Two hours of lecture and 1 hour of discussion. Composition, structure, and physical properties of membranes. Membrane functions including transport, bioelectricity and cell compartmentalization. Specific transport processes in biological systems. Fall (alternate years). Mr. Schaedle.
Prerequisites: One semester of biochemistry and an advanced physiology course, or permission of the instructor.

997. Biology Seminar **(1)**
One hour of lecture-discussion per week. The course emphasizes current concepts and developments in biology. Fall and/or Spring. Staff.

BOTANY (BOTANY AND FOREST PATHOLOGY) (FBO)

510. Mycology **(3)**
Two hours of lecture and 3 hours of laboratory. Fundamentals of the morphology, taxonomy, cytology, life histories and ecology of fungi. Laboratory experience in culturing and identification of fungi. Fall. Mr. Griffin.

515. Systematic Botany **(3)**
Two hours of lecture and 3 hours of laboratory. Identification, nomenclature and classification of flowering plants with special emphasis on local flora and on developing the ability to classify the plants of any region. Fall.
Prerequisite: FBO 310 or permission of the instructor.

530. Plant Physiology **(2)**
Two hours of lecture. Internal processes and conditions in higher plants with emphasis on physiological and biochemical concepts. For students majoring in the biological sciences. Spring. Mr. Wilcox.
Note: Botany majors electing this course for their concentration must also take FBO 531.

531. Plant Physiology Laboratory **(2)**
Two lab sessions. Introduction to current methods and procedures of physiological research including nutrition, tissue culture, photosynthesis, respiration and hormonal regulation of growth. Spring. Mr. Schaedle.
Prerequisites: FBL 330, corequisite FBO 530, or permission of the instructor.

585. Plant Anatomy **(3)**
Two hours of lecture and 3 hours of laboratory. An introductory course in plant anatomy designed to familiarize the student with the organization and development of the primary and secondary plant body of higher plants. Spring. Mr. Tepper.
Prerequisite: FBO 100.

625. Plant Ecology **(3)**
Two hours of lecture and discussion and one laboratory/discussion section per week. A first course in plant community ecology for beginning graduate students focusing on dynamics of community development and change and the processes of community analysis and description. Spring. Mr. Geis.
Prerequisite: A course in general ecology.

630. Fungus Physiology **(3)**
Two hours of lecture and 1 hour of discussion. Principles of growth, reproduction and differentiation of the fungi emphasizing the role of the environment in controlling fungal processes. Spring (even years). Mr. Griffin.
Prerequisites: Two semesters of physiology or biochemistry.

636. Photosynthesis **(3)**
Two hours of lecture and 1 hour of discussion. Advanced study of photosynthesis on the cellular and organismal level. Specific topics will reflect basic concepts and current emphasis in this field. Fall (odd years).
Prerequisite: Two semesters of physiology or a course in biochemistry.

660. Phytopathology **(3)**
Two hours of lecture and discussion and 3 hours of auto-tutorial laboratory. Principles and concepts of plant pathology. Major diseases of ornamental plants, vegetable crops, fruit crops, field crops and trees. This is an introductory plant pathology course for graduate students in all departments. Spring. Mr. Manion.

661. Principles of Forest Pathology **(3)**
Four hours of lecture, discussion and laboratory. Concepts and principles of tree diseases in relation to forest practices and practical experience in disease diagnosis and impact evaluation. Mr. Manion. Fall.
Prerequisite: FBO 360, 660, or consent of instructor.

662. Wood Deterioration by Microorganisms (3)
Two hours of lecture and 3 hours of laboratory/field trip. Major types of fungus defects of wood and its products and principles of control. Special emphasis on chemistry of wood decay, wood durability, toxicants, lumber discolorations, heartrots and decay in forest products. Fall. Mr. Silverborg.
Prerequisite: Organic chemistry, FBO 360, or consent of instructor.

715. Advanced Systematic Botany (2-3)
Lectures and laboratory. Field trips. Advanced study in the identification, nomenclature, and classification of flowering plants. Special emphasis on Gymnospermae, Compositae, and Gramineae. Spring (even years). Mr. Raynal.
Prerequisite: FBO 515 or equivalent.

725. Topics in Plant Ecology (2)
Two hours of seminar-discussion. An advanced course dealing with current research in plant community dynamics. May be repeated for additional credit. Fall.
Prerequisites: FBO 425 or 625 or consent of instructor.

733. Techniques in Plant Physiology (2-4)
Comprehensive study of techniques essential for research in plant physiology. Students may choose the instructors they wish to work with, and should consult the instructors for further details. Fall of every year. May be repeated for credit in different specialties. Staff.
Prerequisites: FBO 530 and 531 or an equivalent physiology course, biochemistry with laboratory, or consent of the instructor.

761. Topics in Phytopathology (3)
Two 2-hour lecture-discussions. Discussions of specific phytopathological subjects. Topic selection is based on availability of expertise and will be announced in advance. Fall or Spring. Staff. This course may be repeated for credit in different specialties.

797. Botany Seminar (1)
Seminar discussions of subjects of interest and importance to the biology of plants. Fall and Spring. Staff.

798. Research in Forest Botany (Credit hours arranged according to nature of problem)
Advanced study in research problems in forest pathology, wood deterioration, tree physiology, anatomy, mycology, ecology, taxonomy and genetics. Typewritten report required. Fall and Spring. Staff.

810. Advanced Mycology, Homobasidiomycetes (3)
Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mrs. Wang.
Prerequisite: FBO 510. Course offered in odd calendar years.

811. Advanced Mycology, Heterobasidiomycetes (3)
Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mrs. Wang.
Prerequisite: FBO 510. Course offered in even calendar years.

812. Advanced Mycology, Ascomycetes (3)
Review of selected literature as well as laboratory training in identification and research techniques. Fall. Mrs. Wang.
Prerequisite: FBO 510. Course offered in even calendar years.

813. Advanced Mycology, Myxomycetes, Phycomycetes, Fungi Imperfecti (3)
Review of selected literature as well as laboratory training in identification and research techniques. Spring. Mrs. Wang.
Prerequisite: FBO 510. Course offered in odd calendar years.

825. Plant Population Ecology **(3)**
Three hours of lecture/discussion per week. An advanced course considering the dynamics of higher plant populations, evolutionary aspects of plant population interaction, and quantitative models. Spring.
Prerequisite: FBO 425 or 625, APM 615 or consent of instructor.

830. Physiology of Growth and Development **(2)**
Lecture. A study of the growth and development of plants and the physiological and biochemical processes that influence the development of form and structure in higher plants. Fall (even years). Mr. Wilcox.
Prerequisite: FBO 530, 585, and organic chemistry or permission of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

CHEMISTRY (FCH)

520. Nuclear and Radiation Chemistry **(2)**
The two 1-hour lectures will cover the information required for the basic understanding of nuclear reactions, the types of radiation emitted, the instrumentation necessary to detect and measure this radiation, the principles of radioisotope tracer techniques and radiation chemistry which is the effect of radiation on organic systems. Visits to the Cornell Reactor and the Nuclear Medicine Department of the Upstate Medical Center will be arranged. Spring. Mr. Meyer.
Prerequisites: Physical, organic and inorganic chemistry or by permission of the instructor.
Note: This course can be taken independently of FCH 521.

521. Nuclear Chemical Techniques **(1)**
The laboratory will consist of one 4-hour laboratory class every 2 weeks, with 1 hour to be made up at the student's discretion to accommodate counting periods which extend over several weeks. A short movie by the AEC each week will be required for the sixth hour. The laboratory will give each student the opportunity to use the individual counting instruments, gain experience in the handling and preparation of radioactive samples and the use of the 1000 Curie-cobalt source in radiation chemistry. Spring. Mr. Meyer.
Prerequisite: Physical, organic and inorganic chemistry or permission of the instructor. Advanced tentative registration is required.
Corequisite: FCH 520.

530. Biochemistry I **(3)**
Three hours of lecture. General biochemistry with emphasis on cellular constituents and metabolic reactions. The chemical, physical and biological properties of amino acids, proteins, carbohydrates and their intermediary metabolism will be discussed. The chemistry of enzymes, energy transfers and biological oxidations will also be covered. Fall. Mr. Campbell.
Prerequisite: One year of organic chemistry.
Pre- or corequisite: One year of physical chemistry

531. Biochemistry Laboratory **(2)**
Six hours of laboratory. This course will stress techniques used in biochemical research. Techniques used include various types of chromatography, electrophoresis, and spectrophotometry and methods involved in the isolation, purification and assay of enzymes. Fall. Mr. Flashner.
Prerequisite: One semester of quantitative analysis with laboratory.

532. Biochemistry II **(3)**
Three hours of lecture. Topics discussed are: application of tracer techniques to biochemistry, the chemical and biochemical properties of lipids, theories on the origin of life, photosynthesis and the biosynthesis of steroids and terpenes, plant aromatics, amino acids, porphyrins and other aspects of nitrogen metabolism. Spring. Mr. Flashner.
Prerequisites: FCH 530 and its pre- and corequisites.

539. Principles of Biological Chemistry **(3)**
Three hours of biochemistry with emphasis on their relationship to biology. Topics include basic metabolic pathways, structure and function of proteins, enzymes, and nucleic acids, energy relationships and biochemical control mechanisms. Fall. Messrs. Campbell and Flashner.
Prerequisite: A 2-semester course in organic chemistry is desirable, but a 1-semester course is acceptable. This course is not open to chemistry majors.

540. Chemical Ecology
This course is the same as FBL 540. Refer to description on page **00**.

551. Polymer Techniques **(2)**
One hour of lecture and discussion and 3 hours of laboratory; lab reports. Techniques of polymer preparation: free radical solution and emulsion polymerization, copolymerization. Molecular weight determination by light scattering, osmometry, viscosity, ultracentrifugation. Structure characterization by X-ray diffraction, electron microscopy, nuclear magnetic resonance, optical rotatory dispersion, polarized microscopy, stress-strain and swelling equilibrium. Fall. Mr. Sarko.
Prerequisites: One year of organic and 1 year of physical chemistry.

552. Polymer Processing and Technology **(3)**
Industrial methods of production and processing of polymeric materials such as fibers, films, plastics, elastomers, foams, composites, adhesives and coatings, including discussions on the correlation between polymer structure and polymer properties. Spring. Mr. Smid and Staff.

610. Aquatic Chemistry **(3)**
Physical properties and chemistry of natural waters will be covered in order to provide an understanding of the nature of the reactions which occur there and the factors which affect those reactions. Fall. Mr. Johnson.
Prerequisites: Physical Chemistry or permission of instructor.

630. Plant Biochemistry **(3)**
Three hours of lecture and discussion. Includes the biochemistry of photosynthetic electron transport and phosphorylation, photosynthetic carbon fixation, photorespiration, nitrogen fixation, nitrate reduction, photochrome and plant hormones. The economic, ecological and environmental aspects of plant biochemistry will also be discussed. Spring. Mr. Campbell.
Prerequisites: FCH 530-532 or FCH 539 or equivalent.

650. Physical Chemistry of Polymers I **(3)**
Three hours of lecture. Includes: thermodynamics of polymer solutions, phase equilibria, fractionation, structure-property relationships, elementary chain statistics, molecular geometry, network elasticity, polyelectrolyte theory and viscosity. Fall. Mr. Smith.
Prerequisites: One year of organic chemistry and 1 year of physical chemistry.

651. Physical Chemistry of Polymers II **(3)**
Three hours of lecture. Viscoelasticity. The glassy state and glass transition temperature. The crystalline state and crystallization kinetics. Characterization of structure and morphology of polymer solid states. Survey of structure and properties of native polymers. Spring. Mr. Sarko.
Prerequisites: One year of organic and 1 year of physical chemistry.

652. Organic Chemistry of Polymers I (3)

Three hours of lecture. A broad survey of the chemistry of polyfunctional molecules and methods for their conversion to high molecular weight materials. Synthesis of a variety of specialty polymers and chemical reactions on natural and synthetic polymers. Some relations between molecular structure and useful properties. Fall. Mr. Caluwe.

Prerequisites: One year of organic chemistry.

653. Organic Chemistry of Polymers II (3)

Three hours of lecture. Kinetics and mechanism of polymerization processes, with emphasis on additional homo- and copolymerization relations initiated by radical, cationic and anionic initiators. Mechanism of stereospecific polymerization. Structure of polymers. Reactions on polymers and their modification for specific end uses. Block and graft polymers. Spring. Mr. Smid.

Prerequisites: One year of organic chemistry and 1 year of physical chemistry.

680. Principles of Physical Chemistry I (2)

Two hours of lecture. Includes advanced discussions on the structure of atoms and molecules, chemical bonding, the structure and properties of matter in gaseous, liquid and solid states. The laws of thermodynamics. Fall.

Prerequisite: One year of physical chemistry.

681. Principles of Physical Chemistry II (2)

Two hours of lecture. Includes advanced discussions on thermodynamics, chemical equilibrium, kinetic theory, chemical kinetics, and electrochemistry. Spring.

Prerequisite: FCH 680 or equivalent.

682. Principles of Organic Structure and Synthesis (3)

Three hours of lectures and discussion. A broad survey of strategies for constructing organic molecules and of physical and chemical methods for the elucidation of structure. Emphasis on material relevant to different chemical disciplines. Fall.

Prerequisites: One year of organic chemistry.

683. Principles of Organic Mechanisms (3)

Three hours of lecture and discussion. A broad survey of organic reaction mechanisms and of techniques and methods used in their elucidation. Emphasis on material relevant to different chemical disciplines. Spring.

Prerequisite: One year of organic chemistry.

796. Special Topics in Chemistry (1-3)
(Credit hours arranged according to nature of topic)

Lectures, conferences and discussion. Advanced topics in physical chemistry, organic chemistry, or biochemistry. Fall and Spring. Staff.

798. Research in Chemistry (Credit hours arranged according to nature of problem)

Independent research in physical and organic chemistry of synthetic polymers, physical and organic chemistry of natural polymers, organic chemistry of natural products, ecological chemistry and biochemistry. One typewritten report required. Fall and Spring. Staff.

850. Organic Chemistry of Polymers (3)

Three hours of lecture, discussion and recitation. A broad survey of polymer forming reactions and polymeric structures. Special problems in stereochemistry, polymerization mechanisms and the synthesis of a variety of specialty polymers. Some relations between molecular structure and useful properties. Spring. Mr. Caluwe.

Prerequisites: One year of organic chemistry and FCH 450.

855. Physical Chemistry of Polymers (3)

Three hours of lecture and discussion. Introduction to statistical mechanics of polymers: general problem of random flight, chain statistics and conformations, partition functions: network statistics and rubber elasticity, birefringence, swelling, crystallization. Scattering phenomena: theory of light scattering, scattering from a sphere, scattering from liquids and solids, anisotrophic scattering, X-ray scattering. Fall or Spring. Mr. Sarko and Mr. Smith.

884. Organic Natural Products Chemistry (3)
Three hours lecture. The chemistry of terpenoids, steroids and alkaloids with an emphasis on the determination of structure by both modern instrumental methods and chemical degradation. Biogenetic considerations and the confirmation of structure by synthesis are covered. Fall or Spring. Mr. LaLonde.
Prerequisite: One semester of advanced organic chemistry.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

997. Seminar (1)
Seminars scheduled weekly; an average of twenty to thirty seminars are given annually. Discussion of recent advances in chemistry. Credit is given only once to a student. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

ENGINEERING (FOREST ENGINEERING) (FEG)

(See: Environmental and Resource Engineering (ERE) Courses.)

ENTOMOLOGY (FOREST ENTOMOLOGY) (FEN)

560. Environmental Toxicology of Insecticides (2)
Two hours of lecture. Basis of action of insecticides in living systems, behavior of insecticides and microtoxicants in environment, interaction of insecticides and biological systems. Fall.
Prerequisite: FBL 330 or equivalent course in physiology or biochemistry.

580. Insect Morphology (3)
Two hours of lecture and 3 hours of laboratory. A comparative study of the external morphology of insects emphasizing evolutionary trends, especially modifications of homologous structures. Topics of special importance include intersegmental relationships, feeding, sensory mechanisms, locomotion and reproduction. Spring. Mr. Kurczewski.
Prerequisite: FEN 350.

610. General Insect Taxonomy (3)
Two hours of lecture and 3 hours of laboratory. Identification and classification of the important orders and families of insects; acquaintance with pertinent taxonomic literature and use of keys; and understanding of evolutionary principles and concepts and a knowledge of systematic theory and practice. Insect collection required. Fall. Mr. Kurczewski.
Prerequisites: FEN 350, FEN 580.

620. Aquatic Entomology (3)
Two hours of lecture and 3 hours of laboratory. The biology, ecology and identification of fresh water insects, with emphasis on the role of aquatic insects in the hydrobiome. Fall. Mr. Brezner.
Prerequisite: FEN 350 or its equivalent.

630. Insect Physiology **(3)**
Two hours of lecture and 3 hours of laboratory. Study of the life processes in insects; introduction to modern physiological instrumentation and laboratory methods. Spring. Mr. Brezner.
Prerequisite: FBL 330.

650. Histological Techniques **(2)**
Two 3-hour laboratories. A study of the series of actions involved in preserving insect tissue through fixation, embedding and staining and the process of observing and identifying tissue sections through microscopic analysis. Fall (even years).
Prerequisites: By permission of instructor.

660. Insecticide Toxicology Laboratory **(2)**
One hour of discussion and 3 hours of laboratory. Laboratory experiments in mode of action and behavior of insecticides, biological and instrumental analysis of insecticides including tracer analyses. Spring (odd years). Mr. Nakatsugawa.
Prerequisite: FEN 560 or equivalent and consent of instructor.

720. Population Dynamics of Forest Insects **(3)**
Two hours of lecture and 1 hour seminar. Interacting environmental factors which influence the relative abundance and distribution of forest insects, ecological principles as applied to problems in forest entomology, and pest management. Introduction to theories of population regulation and the study of the dynamics of forest insect populations; individual seminar. Fall (even years). Mr. Allen.
Prerequisites: FEN 350, FBL 320, APM 491, or equivalents.

796. Special Topics in Forest Entomology
(Credit hours arranged according to nature of work)
Special instruction, conference, advanced study, and research projects in the fields of insect toxicology, insect physiology, taxonomy of immature insects, phases of biology and ecology of insects. Typewritten report required in some fields. Fall and Spring. Staff.

797. Seminar **(1)**
One hour of conference per week. Assigned reports and discussion of topics in entomology. Fall and Spring. Mr. Nakatsugawa and Staff.

798. Research Problems in Forest Entomology
(Credit hours arranged according to nature of problem)
Comprehensive report required in some projects. Fall and Spring. Staff.

810. Advanced Insect Taxonomy **(3)**
Two hours of lecture and 3 hours of laboratory. Methods, procedures and concepts of systematics. Examples and material will be drawn from among important groups of forest insects. Fall. Mr. Lanier.
Prerequisites: FEN 580 and FEN 610.

860. Advanced Toxicology of Insecticides **(3)**
Three hours of lecture and discussion. Review of current topics in toxicology of insecticides and related foreign compounds. Fall. Mr. Nakatsugawa.
Prerequisite: FEN 560, FCH 530 and consent of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

FOREST ZOOLOGY (FZO)

520. Terrestrial Community Ecology **(3)**

Two hours of lecture and 3 hours of laboratory. Relations of terrestrial animals to their physical, chemical and biological environment. Emphasis on community principles, succession and terrestrial adaptations. Fall. Mr. Dindal.

Prerequisite: A course in basic ecology.

525 (Part 1) Physical and Chemical Limnology **(1)**

Modular format and 2 hours of lecture per week for the first 7 weeks of fall semester. An introduction to the physics and chemistry of inland waters with particular emphasis on lakes.

Prerequisites: Junior standing, an introductory physics course and an introductory chemistry course. Fall. Mr. Werner.

525 (Part 2) Introduction to Biological Limnology **(1)**

Modular format and 2 hours of lecture per week for the last 7 weeks of fall semester. An introduction to the biology of inland waters. Particular emphasis is placed on the aquatic environment as a habitat and the effect of changes in this environment on the structure and function of the biological communities contained therein.

Prerequisites: FZO 525 (Part 1). Fall. Mr. Werner.

525 (Part 3) Limnology Laboratory **(1)**

One laboratory or field trip per week. An introduction to limnology techniques and the taxonomy of aquatic organisms. Field trips to local aquatic habitats. FZO 525 (Part 1) and FZO 525 (Part 2) must be taken concurrently or previously. Fall. Mr. Werner.

620. Invertebrate Symbiosis **(3)**

Two hours of lecture and one 3-hour laboratory. An introduction to the ecology and evolution of interspecific relationships of invertebrates. Spring (even years). Mr. Dindal.

Prerequisites: FBL 320, FZO 411.

622. Ecological Energetics **(3)**

Two hours of lecture and 3 hours of laboratory or 1 hour of discussion. Investigation of the principles of energy flow in biological systems. Emphasizing understanding of energy transformations, energy budgets and energy structures of individual organisms, populations and ecosystems. Spring.

Prerequisite: A course in general ecology.

628. Vertebrate Population Ecology **(3)**

Two hours of lecture and one 3-hour laboratory per week. Fundamental parameters of population structure and change with emphasis on vertebrate species. Spring. Mr. Ringler.

Prerequisite: A course in general ecology.

635. Behavioral and Physiological Ecology **(3)**

Two hours of lecture and 1 hour of discussion. An examination of the concepts of animal adaptations to ecological change from a behavioral point of view. Particular emphasis will be placed on the role the environment plays in shaping the behavior of a given species. Behavioral and physiological responses to environmental conditions will be treated as a continuum. Spring Semester (odd-numbered years). Mr. Muller-Schwarze.

650. Biology and Management of Waterfowl **(2)**

A consideration of the identification, life history, ecology and economic importance of waterfowl of the Atlantic Flyway. The management of local, flyway and continental waterfowl populations, including the establishment of hunting seasons, will be discussed. One Saturday field trip. Fall (odd years). Mr. VanDruff.

670. Vertebrate Behavior **(3)**
Two hours of lecture and 3 of laboratory. In-depth study of the major concepts of animal behavior associated with behavioral genetics, development orientation and social behavior. Spring.
Prerequisite: FZO 570.

700. Forest Zoology Trip **(2)**
A 7- to 10-day trip to (1) agencies engaged in zoological research, management, and administration, or (2) regions or areas of unusual biological interest. A final report is required. Estimated student expense, $75.00. Fall or Spring. Staff.

720. Topics in Soil Invertebrate Ecology **(3)**
Two 1-hour lecture-discussion periods and a 3-hour laboratory. Study of literature relating to soil invertebrate microcommunities; taxonomy, culturing and collection methods of soil fauna; student will conduct an individual research problem. Spring (odd years). Mr. Dindal.
Prerequisite: Permission of instructor.

725. Zoogeography **(3)**
Two hours of lecture and 3 hours of laboratory. Geographic distribution of vertebrate animals, factors determining their distribution and nature of range occupied. Fall. (Alternate odd years).

727. Seminar in Aquatic Ecology **(1)**
Two hours of lecture and discussion. A seminar to explore in some depth areas of current research in aquatic ecology. Fall (even years). Messrs. Werner and Ringler.
Prerequisite: Six credits in Aquatic Ecology.

750. Advanced Wildlife Management **(3)**
Two hours of lecture and 3 hours of laboratory. Advanced wildlife management with emphasis on regional and administrative wildlife problems. Extended trips (two weekend trips) are required. Spring. Mr. Chambers.
Prerequisite: FZO 455 or permission of the instructor.

797. Forest Zoology Seminar **(1)**
Two hours of discussion and assigned reports on current problems and new developments in forest zoology. Fall and/or Spring. Staff.

798. Problems in Forest Zoology **(Credit hours to be arranged)**
Hours to be arranged. Individual study of special problems in forest zoology. One typewritten report (original and one carbon) required. Fall and/or Spring. Staff.

835. Invertebrate Physiology **(3)**
Two hours of lecture and 3 hours of laboratory. A study of the physiologic mechanisms employed by invertebrates other than insects in coping with the exigencies of their environment. Fall or Spring (alternate years). Mr. Hartenstein.
Prerequisite: FZO 411 and FZO 330.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring.

950. Topics in Wildlife Biology **(1-3)**
Hours to be arranged. Group study of a wildlife management topic. Fall or Spring. Mr. Chambers.
Prerequisite: Six credits of wildlife management courses.

970. Topics in Animal Behavior **(2)**
Two hours of lecture and discussion. A seminar-type course designed to explore in depth selected and controversial subject areas in animal behavior. Fall or Spring.
Prerequisite: FZO 670 or equivalent.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

LANDSCAPE ARCHITECTURE (LSA)

522. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Studio problems, research, drafting and field trips. Concentration on complex urban problems. Concern for social and psychological considerations of the individual and large groups of people, their interaction and resultant forms of the environment. Spring.
Prerequisite: Permission of instructor.

524. Experimental Landscape Design Studio V **(16)**
Forty-eight hours per week. The articulation of the study proposal established in LSA 425, as approved by faculty, through research, readings, field study with graphic and written documentation, and group discussion. Academic study in an off-campus location in an area of landscape architectural significance, as described and delineated in a student-prepared proposal approved by the faculty. Not available for graduate credit. Fall or Spring.
Prerequisites: LSA 425 or equivalent and LSA 423 or permission of instructor.

525. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Investigation of a problem in landscape architecture as proposed by the student and conducted with faculty advisor. Spring.
Prerequisite: Permission of instructor.

527. Landscape Design Studio VI **(4)**
Twelve hours studio per week. Studio problems, research, reports and field trips. Concentration on regional landscape problems, the techniques of their analysis and derivation of their significance to the practice of landscape design. Spring.
Prerequisite: Permission of instructor.

529. The Major Elements of Environmental Design **(3)**
Lectures, readings, discussions and studios. The course presents an introductory survey of environmental design methods and associated skills and techniques. While studio work is engaged, no design background is required. Fall.

530. Herbaceous Plant Materials **(2)**
Two hours of lectures, study problems, assigned readings and field trips per week. Identification, understanding and design use of nonwoody plants. Fall.
Prerequisite: Permission of instructor.

532. Woody Plant Materials **(3)**
Three hours of lecture per week. Field study, lectures, slide presentations and readings. An elective course providing opportunity for extension of basic knowledge in the identification and design of woody plant materials in professional practice. Fall or Spring.
Prerequisites: LSA 533 and LSA 432 or permission of instructor.

533. Plant Materials **(3)**
Field trips and discussion. Ornamental woody plant identification. Observation and sketches of outstanding examples of planting design. Three weeks, Summer Session.
Prerequisite: Permission of instructor.

542. Highway Location and Design **(3)**
Two hours of lecture and 3 hours of studio per week. Lectures, assigned reading, studio projects, field trips. Environmental, engineering and human factors which determine highway location and design, particularly as they relate to landscape architectural concerns. Location, alignment, geometric design, drainage, roadbed construction, pavements, roadside development. Fall or Spring.
Prerequisites: LSA 343 and 440 or permission of instructor.

545. Professional Practice Studio II **(2)**
Three hours of studio and 1 hour of recitation per week. Studio problems research, discussion and recitation sessions on the processes and methods of office practice. Emphasis on all aspects of site-development. Spring.
Prerequisite: Permission of instructor.

547. Principles of Professional Practice **(2)**
Two hours of lecture per week. Lectures, assigned readings, reports, cost estimates, specifications, contracts, professional ethics, registration laws, professional practice. Spring.
Prerequisite: Upperclass standing.

562. Architecture **(3)**
Two hours of lecture and 3 hours studio. Discussion and investigation of the principles of architectural design and procedures of architectural practice. Functional building systems coupled with site and program considerations as to their relative impacts on architectural form. Spring.
Prerequisite: Permission of instructor.

595. Selected Readings in Landscape Architecture **(1-3)**
Exploration of selected readings in depth with individual independent study upon a plan submitted by the student and related to credit hours assigned. Upon approval of the instructor, the student may systematically investigate some subject area encountered in regularly scheduled courses or may initiate research on a variety of subject areas of determined relevance. Fall, Spring and Summer Session.
Prerequisite: 5th year status or permission of instructor.

597. Landscape Architecture Seminar **(3)**
Three hours of seminar per week. Discussion of current social, political, cultural and technological problems as to their relationship to the physical environment. Fall and Spring.
Prerequisite: Permission of instructor.

598. Research Problem **(1-3)**
Independent study of selected areas of environmental interest. Emphasis on a self-disciplined study, development of procedures and techniques to be employed in environmental design and planning. Engagement with specific sites and problems as proposed for study by individual communities. Fall and Spring. Enrollment at periodic intervals throughout the semester.
Prerequisite: Permission of instructor.

620. Graduate Studio I **(4)**
Twelve hours of studio per week. Disciplines and techniques used by the landscape architect in problem identification, analysis and solution strategies. Emphasis is on processes, not on product. Fall.
Prerequisite: Permission of instructor.

650. Determinants of Urban/Regional Land Use Patterns **(3)**
Three hours of discussion per week. This course will provide an introduction to social science theories of urban and regional land use patterns. The nature of social, economic and political processes are explored in order to determine how the relationship of such factors effects the spatial development of the urban and regional environment. Understanding of these processes provides a basis for urban and regional planning. Fall.
Prerequisite: Permission of the instructor.

651. Process of Urban/Regional Planning **(3)**
Three hours of seminar per week. The purpose of this course is the introduction of planning as a process of decisionmaking and to familiarize graduate students with its scope and content. The course relies upon lectures and readings to develop intro-

ductory knowledge as well as seminars and discussions to cover the constitutional basis, tools, and techniques and the current directions of planning. Spring.
Prerequisite: Permission of instructor.

653. Environmental Land Use Planning (3)
An introduction to the interdisciplinary techniques and emphasis on environmental land use planning. Consideration of the underlying ecological and planning philosophies. Readings and discussions are used in order to familiarize students with the disciplines involved and the process of data analysis, synthesis and plan formulation. Case studies and research projects used to enhance understanding.
Prerequisite: Permission of instructor. Fall and Spring.

654. Urban/Regional Open Space Planning (3)
Three hours of seminar per week. An introduction of concepts of open space planning related to urban, suburban, new town and regional land use. An investigation of contemporary methods for open space preservation through private and municipal efforts will include inventory and analysis techniques for identifying community needs and physical resources. Fall.
Prerequisite: Permission of instructor.

655. Public Policy and the Urban Environment (3)
Three hours of seminar per week. This course investigates public policy decisions as they affect the physical and social patterns of the environment. Seminar discussions based on readings and case study investigation. Spring.
Prerequisite: Permission of the instructor.

697. Seminar—Topics and Issues of Physical Environment (2)
Current topics for discussion are selected in order to acquaint the entering graduate student with a generalized view of the issues of the physical environment. Fall.
Prerequisite: Permission of instructor.

699. Research Methods and Techniques (3)
Three hours of lecture per week. The course examines the design and development of research problems pertinent to landscape architecture and environmental planning. The course will concentrate on three major areas: (1) Areas of Potential Research, (2) Research Methods and Techniques and (3) Proposal Writing. A variety of approaches to research in human-environment interactions will be discussed and explored with reference to their relevance and applicability to graduate research. Spring.
Prerequisite: Permission of Instructor.

711. Human Behavior and Environmental Form (3)
Consideration of the nature and dynamics of people's movements in space as clues to their relationship with their environments. An examination of the basic social and behavioral concepts that relate to the human use of the urban environment. Concepts such as behavior patterns, territoriality, cognitive mapping, urban images, preference, neighborhood and community will be explored within the framework of "social space." The implications of such behavioral studies in the design of the environment will be considered.
Prerequisite: Permission of instructor. Fall and Spring.

720. Graduate Studio II (4)
Twelve hours of studio per week. A multidisciplinary approach to the solution of one or more environmental problems of concern to the landscape architect. Because of the multivariable complexity of environmental problems, students pursuing various degree programs are invited to utilize this studio. Spring.
Prerequisite: LSA 620 or permission of instructor.

721. Graduate Studio III (4)
Twelve hours of studio-workshop per week. This is an extension of LSA 720, Graduate Studio II, with the engagement of additional problems. Fall.
Prerequisite: LSA 720 or permission of instructor.

730. Plant Materials IV **(2)**
Lecture, field work, trips. Special study of woody and herbaceous plant materials, greenhouse operation and other horticultural practices. Spring.

731. Plant Materials **(3)**
Seminars, individual conferences, field trips, readings. Guided individual study in aspects of plant materials related to landscape architecture. Fall or Spring.
Prerequisite: LSA 730 or permission of instructor.

740. Landscape Architectural Construction **(3)**
Lectures, drafting. Detailed study of special landscape construction problems. Preparation of estimates, contracts and specifications. Fall.
Prerequisite: LSA 542.

752. Methods of Urban and Regional System Dynamics **(3)**
Lectures and workshop. The major concerns of this course are application of system dynamics; basic principles of system dynamics; and system dynamics modeling. This method is investigated as a useful tool in modeling many landscape architectural and planning problems. No prior computer experience is necessary. Fall.
Prerequisite: Permission of instructor.

757. Methods of Corridor Location **(3)**
Three hours of lecture per week. This course emphasizes study of corridor types, traditional economic determinism, and the emergence of environmental, aesthetic and social concerns. Landscape architectural methods for corridor location and evaluation are reviewed and compared. These methods include graphic overlays, an automated data bank, unified scoring systems, and multiple accounts. Students will engage a course project. Spring.
Prerequisite: Permission of instructor.

797. Seminar **(2)**
Two hours per week. Discussion of current topics, trends and research related to landscape architecture, planning, and management. Fall and Spring.
Prerequisite: Permission of instructor.

798. Research Problem
(Credit hours to be arranged according to nature of problem)
Special study of assigned problems relating to landscape architecture or planning, with emphasis on critical thinking. Fall and Spring.
Prerequisite: Permission of instructor.

799. Thesis Project Proposal Development **(1)**
One hour lecture/workshop per week. During this course, a student will prepare a proposal for a thesis/project in the MLA program. Fall.
Prerequisites: LSA 699 and permission of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring.

PAPER SCIENCE AND ENGINEERING (PSE)

(See Environmental and Resource Engineering (ERE) Courses.)

RESOURCE MANAGEMENT AND POLICY (RMP)

587. Environmental Law **(3)**
Three hours of lecture and discussion. Studies in Environmental Law designed for resource managers. Review of structure and processes of American legal system, constitutional framework of environmental law, The National Environmental Policy Act, legal framework for management of Federal lands, focus on legal aspects of common property resource management, land, water and air.
Prerequisites: Open to undergraduate seniors.

588. The Law of Natural Resource Administration (3)
Three hours of lecture and discussion. An introduction to the law concerning the procedures, powers and judicial review of public agencies responsible for the management of natural resources. Topics will include the extent of an agency's rule-making power and the rights of aggrieved parties to appeal from agency decisions. Spring. Mr. Horn.
Prerequisite: ERM 460 or equivalent course in public administration.

601. Resource Management Systems (3)
Three hours of lecture and seminar per week. Review of the structure and operation of the ecological and social environment within which resource managers operate. Major characteristics of the ecological utilization and control systems for forest and related natural resources are described and compared. Fall.

602. Resource Economics (3)
Three hours of lecture and discussion per week. Economic theory and analysis in resource management and use decisions. Study and application of economic models to land, water, forest, wildlife and recreational resources. Relationships and interactions of public and private sector in resource management. Fall.

603. Research Methods in Resource Management and Policy (3)
Three hours of lecture and discussion per week. Study of the elements of research methodology including statistics and their application to analyzing and resolving problems both basic and applied in the managerial and policy sciences. Fall.

606. Management Principles and Processes (3)
Three hours of lecture and group discussion. The central focus of this course is on decisionmaking, organization and information theories as they relate to the total management process. Spring.
Prerequisite: Basic understanding of management functions and processes as found in ERM 360. Available to qualified seniors.

611. Economics of the Forest Business (3)
Two hours of lecture and 3 hours of laboratory. Economic evaluation of alternative uses of land, labor and capital in the operation of forest properties and related marketing and processing enterprises. Emphasis is on application of principles and methods of economic analysis. Part of the term is spent in appraising a forest property and preparing a plan for its operation. Complementary to instruction in ERM 456. Spring. Mr. Christiansen.
Prerequisite: ERM 463 or permission of instructor.

629. Environmental Impact: Principles and Strategies (3)
Three hours of lecture and discussion. Principles and theory of environmental impact and statements of impact as required by Federal law. Administrative procedures for review and evaluation. Procedural strategy and effective constitution of statements for various governmental levels. Means of obtaining sources of authoritative information. Fall and Spring. Mr. Black.

640. Analysis and Control of Forestry Operations (3)
Two hours of lecture and 3 hours laboratory. Applications of scientific methods to management decision problems of forestry operations with emphasis on data sources and reliability, model formulation, inventory control, equipment replacement, simulation, and critical path scheduling and costing. Fall.
Prerequisites: APM 491 or equivalent, ERM 373 and computer programming.

641. Soil and Water Conservation (3)
Three hours of lecture and discussion. An integrated examination of the many aspects of the field of water and related land resource conservation in the United States. Topics include the evaluation and present status of planning, organizational, economic and legal constraints on the development of policies and programs of the Federal agencies, state and local government and private units. Fall. Mr. Black.
Prerequisite: Permission of the instructor.

642. Water Quality Management (3)
Three hours of lecture and seminar per week. The review of the ethical, historical, legal and technical basis for water quality management. Investigation of public policy on the international, Federal, state and local levels and the administrative methods and programs used to implement policy. Fall. Mr. Hennigan.

643. Urban Water Management (3)
Three hours of lecture and seminar per week. A review of the role of urban water management in water resources management. The problems and issues of providing water utilities services of water supply, drainage and waste water facilities including such considerations as planning, financing, local government, intergovernmental relations, state and Federal role, water institutions and applicable law. Spring. Mr. Hennigan.

650. Forestry and Economic Development (3)
Three hours of lecture and discussion. Study of the role of forest resources in the process of economic development. Characteristics of forest resources which are important for economic development are analyzed in detail. Interrelationships between biological, technological and institutional factors are stressed. Fall. Mr. Petriceks. Offered to seniors and graduate students in environmental and resources management. Open to others by permission of instructor.
Prerequisite: ERM 463 or its equivalent.

662. Land Use Economics (3)
Three hours of lecture/discussion per week. Study of the theory and methods of land use economics and the application of economic analysis to open space and regional planning. Emphasis is on understanding basic concepts, developing of operational methods and data sources. Case studies, outside readings, and guest speakers are utilized. Fall. Mr. Canham.
Prerequisite: One course in macroeconomics and one in microeconomics and permission of instructor.

670. Economics of Nonmarket Goods (3)
Group discussion, lectures, guided readings, case studies and student projects on the economic aspects of watershed management, fish and wildlife management, and outdoor recreation. Major topics include theories of valuation and application to nonmarket goods, cost analysis for nonmarket goods, and measurement of regional impacts. Spring.
Prerequisites: ERM 204 or 206 or equivalent, knowledge of basic statistical analysis, and 6 hours or more of resource management coursework.

672. Open Space Planning (Recreation) (3)
Three hours of lecture/discussion per week. Study of methods and techniques applicable to open space planning in nonurban areas. Survey of literature and current research. Open space standards, classification systems and inventory methods. Development of plans for large scale recreation areas, and inclusion of recreation into regional plans. The interrelationship and conflicts between resource utilization/development and recreation/aesthetics reviewed through case studies. Fall. Mr. Gratzer.
Prerequisite: One course in outdoor recreation, one course in planning, and permission of instructor.

675. Social Psychology of Leisure Behavior (3)
Three hours of lecture and discussion. Introduction to theory and research findings dealing with the sociological and psychological aspects of leisure behavior: field work and lectures demonstrate applications, particularly in outdoor recreation. Spring. Mr. Morrison.

751. World Forestry **(3)**
Three hours of lecture and discussion. World forest distribution and types; regional production and consumption of forest products; international trade in timber and related products; the role of forest resources in development; and special topics; tropical forestry, comparative forest policies and programs, forestry education, the problems of developing countries, international cooperation in forestry development, the role of the United States in world forestry, etc. Fall or Spring. Staff.
Prerequisite: Graduate status.

752. Applied Forest Management **(3)**
Principles and practices of forest management as applied to specific forest properties under the guidance of responsible public and private foresters. Several days are spent in the field studying forest conditions, organizations, operations, and problems. By observing actual forest operations, students become acquainted with the latest and most efficient forest practices in office and forest. Fall. Mr. Horn.

753. Resources Policy **(3)**
Three hours of lecture and seminar. Evaluation of basic environmental and resource issues and their evolvement in public and institutional policies. Exploration of alternative resource goals, policies, and program approaches and their implications. Analysis of processes for policy delineation and modification. Spring. Mr. Graves.

754. Advanced Forest Administration **(3)**
Critical appraisal of existing public, semipublic and private forestry agencies in the United States, and the comparative study of major administrative organizations and practices. Occasional inspection trips to forestry headquarters and field units and discussion of internal administrative problems with forest officers. Fall or Spring.
Prerequisite: ERM 460 or equivalent.

756. Management Concepts in Planning Forest Production **(3)**
Three hours of lecture and discussion. The theories and principles involved in planning the annual allowable cut and the resulting yearly cutting schedules. The influence of technical decision and socioeconomic pressures upon the level of cutting and the effect of the level of cutting upon the dependent industry. Fall or Spring. Mr. Koten.
Prerequisite: ERM 476 or equivalent.

797. Seminar **(1)**
Group discussion and individual conference concerning current topics, trends and research in management. Fall and Spring. Staff.

798. Research Problems in Resources Management and Policy
(Credit hours arranged according to nature of problem)
Special investigation and analysis of resources management problems where integrative relationships of several subject aspects of forestry are a major consideration. Fall and Spring. Staff.

800. History of Economic Thought in Forestry **(3)**
Three hours of discussion or conference. Systematic study and critique of the development of the thinking of foresters and economists with respect to some segment of the subject matter of forestry economics. Review of major individual contributions to thought and the influence of leading scholars upon the thinking of others. Appraisal of the leading schools of thought. Offered only to graduate students. Fall or Spring. Mr. Bennett.

840. Professional Workshop in Forestry Economics **(3)**
Two hours of seminar and one 3-hour laboratory each week. RMP 840 is an internship-workshop in the interpretation of forest economics. The seminars are devoted to problems of programming, materials, instruction, testing and evaluation. The laboratory incorporates leading a 1-hour discussion group in ERM 206 with preparation for

that discussion group and with the writing of a report on the laboratory to be used in a subsequent seminar meeting. Fall. Mr. Bennett.

Prerequisite: Econ 605, Econ 606, or permission of instructor.

899. Master's Thesis Research (Credit hours to be arranged)

Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research (Credit hours to be arranged)

Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

SCHOOL OF CONTINUING EDUCATION (SCE)

510. Creative Problem Solving Seminar (3)

Three hours of lecture and discussion per week. A course designed to extend the students understanding and application of creative problem solving processes. One requirement will be to select and carry out an application of the techniques to a particular problem, with consultation and guidance from the instructor. Critique and survey of the literature on creativity, in-depth analysis of the synectics process and various procedures which have been developed for nurturing creative behavior comprise the essence of the program.

Prerequisites: Undergraduate degree or permission of instructor.

530. (FEN) Pest Identification, Biology and Management (3)

A study of the life history and management practices for pests common to the home, landscape and recreational areas. Suggested for pest control personnel and teachers of primary and secondary science areas. Not open to College of Environmental Science and Forestry students. Summer.

Prerequisite: One course in biology.

576. Special Topics Course: Environmental Education Processes and Strategies (3)

Lectures, discussions, field problems and structured outdoor laboratory assignments in environmental education processes and strategies for professional educators in elementary and secondary schools who are part-time, nonmatriculated at ESF. Summer.

Prerequisite: Consent of instructor. Not acceptable for credit in graduate programs of the School of Environmental and Resource Management.

596. Special Topics in Resource Management (1-3)

Lectures, field exercises, guided readings and discussions, in a short course format. The study of recent developments and applications in resource management. Illustrative topics include management of forest stands, resource economics, land planning or recreation planning and site development. Summer. Not acceptable for credit in graduate programs of the School of Environmental and Resource Management.

Prerequisite: Permission of instructor.

SILVICULTURE (SIL)

553. Energy Exchange at the Earth's Surface (3)

Two hours of lecture and 3 hours of laboratory. A comprehensive study of the physical processes taking place in the lowest layer of the atmosphere. Primary emphasis on the turbulent transfer of heat, momentum and water vapor and the expression of these fluxes in the microclimate. Spring. Mr. Herrington.

Prerequisite: ERM 452, physics and calculus.

625. Productivity of Forest Stands (3)

Examination of forest tree and stand production variables as related to silvicultural manipulation. Analysis of stand response, such as rate of growth, stem form, product quality, tree quality and value. Preparation of stand treatment schedules. Spring. Mr. Richards and Mr. Johnson.

Prerequisite: Permission of instructor.

632. Soil Genesis, Morphology and Classification (3)
Three hours of lecture and/or discussion. A comprehensive study of the soil developmental processes and the resulting morphology. Emphasis is placed on the classification of soils. Some details on soil survey and mapping are included. Spring. (Even years). Mr. Craul.
Prerequisites: An introductory soils course or permission of instructor.

640. Advanced Wildland Hydrology (3)
Lecture, discussion and laboratory sessions in advanced problems of forest and range hydrology, watershed management methods and techniques and evaluation of new methods of hydrologic data collection and analysis. Fall. Mr. Black.
Prerequisites: ERM 440 or FEG 340.

641. Watershed Analysis (3)
One hour of lecture and 6 hours of laboratory each week. Lecture and field experience in watershed characterization, inventory, and analysis in terms of land management problems. Fall. Mr. Black.
Prerequisites: ERM 440 and permission of instructor.

642. Snow Hydrology (3)
Three 1-hour lectures per week and two 3-day field trips. Physical characteristics of snow and the energy relations important in its accumulation and dissipation. Problems of measurement and prediction of runoff and melt. Potentials for management. Spring. Mr. Eschner.
Prerequisite: ERM 440 or FEG 340.

677. Advanced Forest Tree Improvement (3)
Two hours of lecture and discussion and 3 hours of laboratory. A study of advanced principles and techniques for genetic improvement of forest trees. Special emphasis is placed on selection and breeding for growth rates, wood quality and insect and disease resistance. Problems of tree hybridization, racial variations, sexual reproduction, and quantitative genetics in forest trees. Laboratory training in cytology and cytogenetics, pollen germination, vegetative propagation and other problems. Independent research problems will be undertaken by the student. Fall or Spring. Mr. Westfall.
Prerequisite: FBL 370 and 371, ERM 455.

730. Research Methods in Silviculture (3)
Three hours of lecture or discussion. Research concepts and methodology with particular application to silviculture and its related sciences. More appropriate to beginning students or before taking thesis work. Fall. Staff.
Prerequisite: Permission of instructor.

735. Forest Soil Fertility (Applied Studies) (2-4)
Two hours of lecture and 1 hour of discussion. Up to 6 hours of laboratory depending on number of credit hours. Influence of soil fertility on development and growth of seedlings and trees, and techniques involved to determine this influence. Chemical and biological analysis to determine levels of soil fertility. Nutrient element deficiencies and their correction by soil amendments and fertilizers. Term projects by the student will be undertaken. Spring. Mr. Leaf.
Prerequisites: CHE 332 and 333, FBO 530, ERM 446, or equivalent.

737. Forest Soil Physics (4)
Three hours of lecture and discussion and 3 hours of laboratory. Presentation of principles of soil physics including water flow, storage and availability, soil permeability, heat transfer, and their consideration as root environmental factors. Analytical procedures are introduced and evaluated. Applications of soil physics to silvics, soil fertility, watershed management and hydrology, soil biology and land-use. Spring. (Odd years). Mr. Craul.
Prerequisites: ERM 345, 446, or their equivalents. Physical chemistry and integral calculus strongly recommended.

777. Quantitative Genetics in Forest Tree Improvement **(3)**
Two-hour lecture and discussion and 3 hours laboratory. Development of statistical models for determining heritability in forest trees. Breeding models and computer analysis application in forest genetics. Fall or Spring. Mr. Westfall.

797. Graduate Silviculture Seminar **(1)**
Three-hour class discussion per week. Assigned reports and discussion of silvicultural topics. Fall and Spring. Staff.

798. Research Problems in Silviculture
(Credit hours arranged according to nature of problem)
Hours to be arranged. Fall and Spring. Staff.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring. Staff.

999. Doctoral Thesis Research **(Credit Hours to be Arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring. Staff.

WOOD PRODUCTS ENGINEERING (WPE)

(See Environmental and Resource Engineering (ERE) Courses.)

State University of New York

STATE UNIVERSITY OF NEW YORK

The State University of New York, now in its 29th year of service, is the largest, centrally managed, multi-level system of public higher education in the nation.

Since its founding in 1948, through consolidation of 29 State-supported but unaffiliated campuses, the University has grown in response to need until its services are now felt educationally, physically and culturally, the length and breadth of New York State.

The University's 64 geographically dispersed campuses bring educational opportunity within commuting distance of virtually all New York citizens. In many communities, the SUNY campuses are cultural centers of the area and a significant contributor to the local economy.

In academic 1976-77, nearly 344,000 students were studying in its classrooms or pursuing study at home, at their own pace, through such innovative institutions as Empire State College, a campus without walls. More than 100,000 students are 24 years of age or older, reflecting SUNY's ability to adjust to meet the needs of more mature students.

During its relatively brief existence, it has graduated more than 600,000 alumni, the majority of whom are pursuing their careers in villages, towns and cities across the State.

The State University welcomes not only the future architects, business executives, engineers, surgeons and literary critics, but also future dairy farmers and medical technicians, accountants and social workers, foresters and automobile mechanics. And through work in film, electronics, pollution control, data processing, police science, urban studies and similar fields, the University seeks to educate persons for tomorrow's roles as well as those of today.

To provide such opportunity on a continuing basis, the University is uniquely organized into a system comprised of:

Four University centers (two of which, Buffalo and Stony Brook, include health science centers); two medical centers; 13 colleges of arts and science, a nonresidential college; three specialized colleges, six agricultural and technical colleges; five statutory colleges administered in cooperation with Cornell and Alfred Universities; and 30 locally-sponsored community colleges.

In addition to baccalaureate studies, 12 of the senior campuses offer graduate study at the doctoral level, and 22 at the master's level.

The two-year colleges offer associate degree opportunities in arts and science in a wide range of technical areas. They also provide transfer programs within the University for students wishing to continue to the baccalaureate degree.

Ten Educational Opportunity Centers serve the educationally deprived by upgrading occupational skills for more gainful employment and identifying students with college potential to prepare them for enrollment in the State's public and private colleges.

Overall, at its EOC's, two-year colleges, four-year campuses and university and medical centers, the University offers 3,500 academic programs.

State University is governed by a Board of Trustees, appointed by the Governor, which determines the policies to be followed by the 34 State-supported campuses.

The 30 community colleges operating under the program of State University have their own local board of trustees. The State contributes 30 to 40 percent of their operating costs and one-half of their capital costs.

The State University motto is "Let Each Become All He Is Capable of Being."

STATE UNIVERSITY OF NEW YORK

UNIVERSITY CENTERS

State University at Albany
State University at Binghamton
State University at Buffalo
State University at Stony Brook

COLLEGE OF ARTS AND SCIENCE

College at Brockport
College at Buffalo
College at Cortland
Empire State College
College at Fredonia
College at Geneseo
College at New Paltz
College at Old Westbury
College at Oneonta
College at Oswego
College at Plattsburgh
College at Potsdam
College at Purchase
College at Utica/Rome

COLLEGES AND CENTERS FOR THE HEALTH SCIENCES

Health Sciences Center at Buffalo University Center
Health Sciences Center at Stony Brook University Center
Downstate Medical Center at Brooklyn
Upstate Medical Center at Syracuse
College of Optometry at New York City
College of Veterinary Medicine at Cornell University*

AGRICULTURAL AND TECHNICAL COLLEGES

College at Alfred
College at Canton
College at Cobleskill
College at Delhi
College at Farmingdale
College at Morrisville

SPECIALIZED COLLEGES

College of Agriculture and Life Sciences at Cornell University*
College of Ceramics at Alfred University*
College of Environmental Science and Forestry at Syracuse
College of Human Ecology at Cornell University*
Fashion Institute of Technology at New York City
Maritime College at Fort Schuyler
School of Industrial and Labor Relations at Cornell University*

COMMUNITY COLLEGES

(Locally-sponsored, two-year colleges under the program of State University)

Adirondack Community College at Glens Falls
Broome Community College at Binghamton
Cayuga County Community College at Auburn
Clinton Community College at Plattsburgh
Columbia-Greene Community College at Hudson
Community College of the Finger Lakes at Canandaigua
Corning Community College at Corning
Dutchess Community College at Poughkeepsie
Erie Community College at Buffalo
Fulton-Montgomery Community College at Johnstown
Genesee Community College at Batavia
Herkimer County Community College at Herkimer
Hudson Valley Community College at Troy
Jamestown Community College at Jamestown
Jefferson Community College at Watertown
Mohawk Valley Community College at Utica
Monroe Community College at Rochester
Nassau Community College at Garden City
Niagara County Community College at Sanborn
North County Community College at Saranac Lake
Onondaga Community College at Syracuse
Orange County Community College at Middletown
Rockland Community College at Suffern
Schenectady County Community College at Schenectady
Suffolk County Community College at Selden
Sullivan County Community College at South Fallsburg
Tompkins Cortland Community College at Dryden
Ulster County Community College at Stone Ridge
Westchester Community College at Valhalla

*These operate as "contract colleges" on the campuses of private universities.

College of Environmental Science and Forestry

ESF BOARD OF TRUSTEES

COLLEGE ADMINISTRATION

President .... EDWARD E. PALMER
Assistant to the President .... JAMES C. JOSEPH
Assistant to the President for Community Relations .... ROLLA W. COCHRAN

Vice President for Program Affairs .... RICHARD E. PENTONEY
Assistant Vice President for Research Programs .... DONALD F. BEHREND
Assistant Vice President for Academic Programs .... ROBERT H. FREY
Coordinator of Sponsored Programs .... J. DONALD MABIE
Executive Director, Institute of Environmental Program Affairs (IEPA) . DONALD F. BEHREND
Coordinator of Demonstration and Information, IEPA .... ROLLA W. COCHRAN
Coordinator of Research, IEPA .... RAYMOND L. MARLER

Vice President for Student Affairs .... HARRISON H. PAYNE
Director of Admissions .... ROBERT L. FRIEDMAN
Financial Aids Coordinator .... JOHN R. REEVES
Registrar .... DONALD F. GREEN
Adjunct Foreign Student Counselor .... VIRGINIA T. TORELLI

Vice President for Administration and Services .... DAVID G. ANDERSON
Director of Business and Fiscal Affairs .... HARRY J. CORR
Librarian .... DONALD F. WEBSTER
Director of Educational Communications (Acting) .... BERNARD T. HOLTMAN
Director of Computer Services .... CHARLES N. LEE
Director of Personnel .... STEPHEN H. MONTGOMERY
Director of Physical Plant .... BRUCE E. REICHEL
Coordinator of Facilities .... CHARLES N. LaFORTY
Director of Campus Safety and Security .... JOHN F. LITCHER
Associate for Institutional Research .... RHONDDA K. CASSETTA
Director of Analytical and Technical Services .... JOHN A. MEYER
Affirmative Action Officer .... ALTON W. ZANDERS

Dean, School of Biology, Chemistry and Ecology .... STUART W. TANENBAUM
Dean, School of Continuing Education .... JOHN M. YAVORSKY
Dean, School of Environmental and Resource Engineering .... WILFRED A. COTE, JR.
Dean, School Environmental and Resource Management .... CHARLES C. LARSON
Dean, School of Landscape Architecture .... ROBERT G. REIMANN
Director, School of Forest Technology .... DANIEL M. CASTAGNOZZI
Director, Graduate Program in Environmental Science .... ROBERT D. HENNIGAN
Director, Adirondack Ecological Center .... WILLIAM C. TIERSON
Director, Applied Forestry Research Institute .... RAYMOND L. MARLER
Director, Empire State Paper Research Institute .... BENGT LEOPOLD
Director, State University Polymer Research Center .... MICHAEL M. SZWARC
Director, Ultrastructure Studies Center .... WILFRED A. CÔTÉ, JR.
Director, Tropical Timber Information Center .... ROBERT W. DAVIDSON
Director, Cellulose Research Institute .... TORE E. TIMELL
Project Leader, U.S. Forest Service Cooperative Research Unit .... J. ALAN WAGAR

COLLEGE FACULTY AND PROFESSIONAL STAFF

This listing represents an official record of the State University of New York College of Environmental Science and Forestry faculty and professional staff for 1977. It is designed for use in 1977-78. Any changes should be filed with the Office of Personnel.

The date in parentheses after each name denotes the first year of service, two or more dates, the term of service. An asterisk (*) indicates graduate faculty.

LAWRENCE P. ABRAHAMSON (1977), *Senior Research Associate,* Applied Forestry Research Institute; B.S., Michigan Technical University, 1964; M.S., University of Wisconsin, 1967; Ph.D., University of Wisconsin, 1969.

MAURICE M. ALEXANDER (1949)*, *Professor and Chairman,* Department of Forest Zoology; B.S., State University of New York College of Forestry, 1940; M.S., University of Connecticut, 1942; Ph.D., State University of New York College of Forestry, 1950

DOUGLAS C. ALLEN (1968)*, *Associate Professor,* Department of Forest Entomology; B.S., University of Maine, 1962; M.S., 1965; Ph.D., University of Michigan, 1968

IRA H. AMES (1972), *Adjunct Associate Professor,* Department of Botany and Pathology; B.A., Brooklyn College, 1959; M.S., New York University, 1962; Ph.D., 1966

DAVID G. ANDERSON (1959), *Vice President for Administration and Services; Associate Professor;* A.A.S., State University of New York College of Forestry (Ranger School), 1950; B.S., State University of New York College of Forestry, 1953; M.S., University of Utah, 1958

ROBERT E. ANTHONY (1953), *Technical Specialist,* Department of Botany and Pathology; A.A.S., State University of New York Agricultural and Technical College at Morrisville, 1952

GEORGE R. ARMSTRONG (1950)*, *Professor,* Department of Managerial Science and Policy; B.S., State University of New York College of Forestry, 1949; M.S., 1959; Ph.D., 1965

ROBERT W. ARSENEAU (1972), *Programmer/Analyst,* Computer Center; A.A.S., Mohawk Valley Community College, 1967

JAMES P. BAMBACHT (1967)*, *Associate Professor,* Department of Paper Science and Engineering; A.B., Kalamazoo College, 1954; M.S., The Institute of Paper Chemistry, 1956; Ph.D., State University of New York College of Environmental Science and Forestry, 1973

C. ELLISON BECK (1970), *Technical Specialist,* Analytical and Technical Services, Office of the Vice President for Administration and Services

DONALD F. BEHREND (1960-67) (1968)*, *Assistant Vice President for Research Programs; Executive Director of the Institute of Environmental Program Affairs; Senior Research Associate;* B.S., University of Connecticut, 1958; M.S., 1960; Ph.D., State University of New York College of Forestry, 1966

ROBERT M. L. BELLANDI (1974), *Research Assistant,* Institute of Environmental Program Affairs; B.S., Montana State University, 1972; M.R.P., Syracuse University, 1973

LEE U. BENDER (1970)*, *Associate Professor,* Department of Forest Engineering; A.A.S, State University of New York College of Forestry, (Ranger School), 1953; B.S., State University of New York College of Forestry, 1959; M.S., 1960; Ph.D., Ohio State University, 1971

JOHN D. BENNETT (1960)*, *Associate Professor,* Department of Managerial Science and Policy; B.A., Ohio Wesleyan University, 1954; Ph.D., Syracuse University, 1968; *Chancellor's Award for Excellence in Teaching* (1973)

CAMILLO BENZO (1975), *Adjunct Associate Professor,* Department of Forest Zoology; B.A., Utica College of Syracuse University, 1964; Ph.D., University of Pennsylvania, 1969

JOHN V. BERGLUND (1965)*, *Professor and Chairman,* Department of Silviculture and Forest Influences; B.S., Pennsylvania State University, 1962; M.S., 1964; Ph.D., State University of New York College of Forestry, 1968

WILLIAM H. BETTINGER (1972), *Technical Specialist,* Analytical and Technical Services, Office of the Vice President for Administration and Services

DONALD H. BICKELHAUPT (1969), *Technical Assistant*, Department of Silviculture and Forest Influences; B.S., State University of New York College of Forestry, 1969

PETER E. BLACK (1965)*, *Professor*, Department of Silviculture and Forest Influences; B.S., University of Michigan, 1956; M.F., 1958; Ph.D., Colorado State University, 1961; *Executive Chairman of the Faculty* (1974-76) (1976-78)

WILLIAM R. BORGSTEDE (1971), *Technical Assistant*, Department of Forest Zoology; A.A.S., Minor Institute, 1966; A.A.S., State University of New York College at Delhi, 1970; B.S., State University of New York College of Environmental Science and Forestry, 1975

JEROME BREZNER (1961)*, *Professor*, Department of Forest Entomology; A.B., University of Rochester, 1952; A.M., University of Missouri, 1956; Ph.D., 1959

ROBERT H. BROCK, JR. (1967)*, *Professor*, Department of Forest Engineering; B.S., State University of New York College of Forestry, 1958; M.S., 1959; Ph.D., Cornell University, 1971

RANIER H. BROCKE (1969)*, *Senior Research Associate*, Adirondack Ecological Center; B.S., Michigan State University, 1955; M.S., 1957; Ph.D., 1970

ALTON F. BROWN (1963) *Technical Specialist*, Empire State Paper Research Institute

KENNETH F. BURNS (1970), *Technical Assistant*, Applied Forestry Research Institute; A.A.S., Paul Smith's College, 1969

HARRY W. BURRY (1962), *Extension Specialist*, Applied Forestry Research Institute; *Associate Professor*; B.S., State University of New York College of Forestry, 1941; M.F., 1964

PAUL M. CALUWE (1969)*, *Senior Research Associate*, Department of Chemistry; M.S., University of Louvain, 1964; Ph.D., 1967

ROBERT L. CALVER (1976), *Director of Development*, Alumni/Development Office, B.A., University of South Dakota, 1971

ROBERT CAMERON (1974), *Research Assistant*, Adirondack Ecological Center; State University of New York College of Environmental Science and Forestry (Ranger School), 1973

ROBERT W. CAMPBELL (1972)*,*Adjunct Associate Professor*, Department of Entomology; B.S., State University of New York College of Forestry, 1953; M.F., University of Michigan, 1959; Ph.D., 1961

WILBUR H. CAMPBELL (1975), *Assistant Professor*, Department of Chemistry; A.A., Santa Ana College, 1965; B.A., Pomona College, 1967; Ph.D., University of Wisconsin, 1972

HUGH O. CANHAM (1966)*, *Assistant Professor*, Department of Managerial Science and Policy; B.S., State University of New York College of Forestry, 1960; M.S., 1962; Ph.D., 1971

DIANNE M. CAPRITTA (1967), *Associate Librarian*, F. Franklin Moon Library; B.S., University of Illinoms, 1965; M.S.L.S., Syracuse University, 1967

RHONDDA K. CASSETTA (1967), *Associate for Institutional Research*, Office of the Vice President for Administration and Services; A.B., Elmira College, 1933

DANIEL M. CASTAGNOZZI (1956), *Professor and Director*, School of Forest Technology; A.A.S., State University of New York College of Forestry (Ranger School), 1950; B.S.F., University of Michigan, 1952; M.F., State University of New York College of Forestry, 1957

ROBERT E. CHAMBERS (1967)*, *Associate Professor*, Department of Forest Zoology; B.S., Pennsylvania State University, 1954; M.S., 1956; Ph.D., Ohio State University, 1972

WALLACE CHRISTENSEN (1975), *Adjunct Professor*, Department of Managerial Science and Policy; State University of New York College of Forestry (Ranger School), 1946; B.S.F., University of Michigan, 1949; M.F., State University of New York College of Forestry, 1954; Ph.D., 1957

WILLIAM M. CHRISTIAN (1974), *Technical Assistant*, Department of Security and Safety

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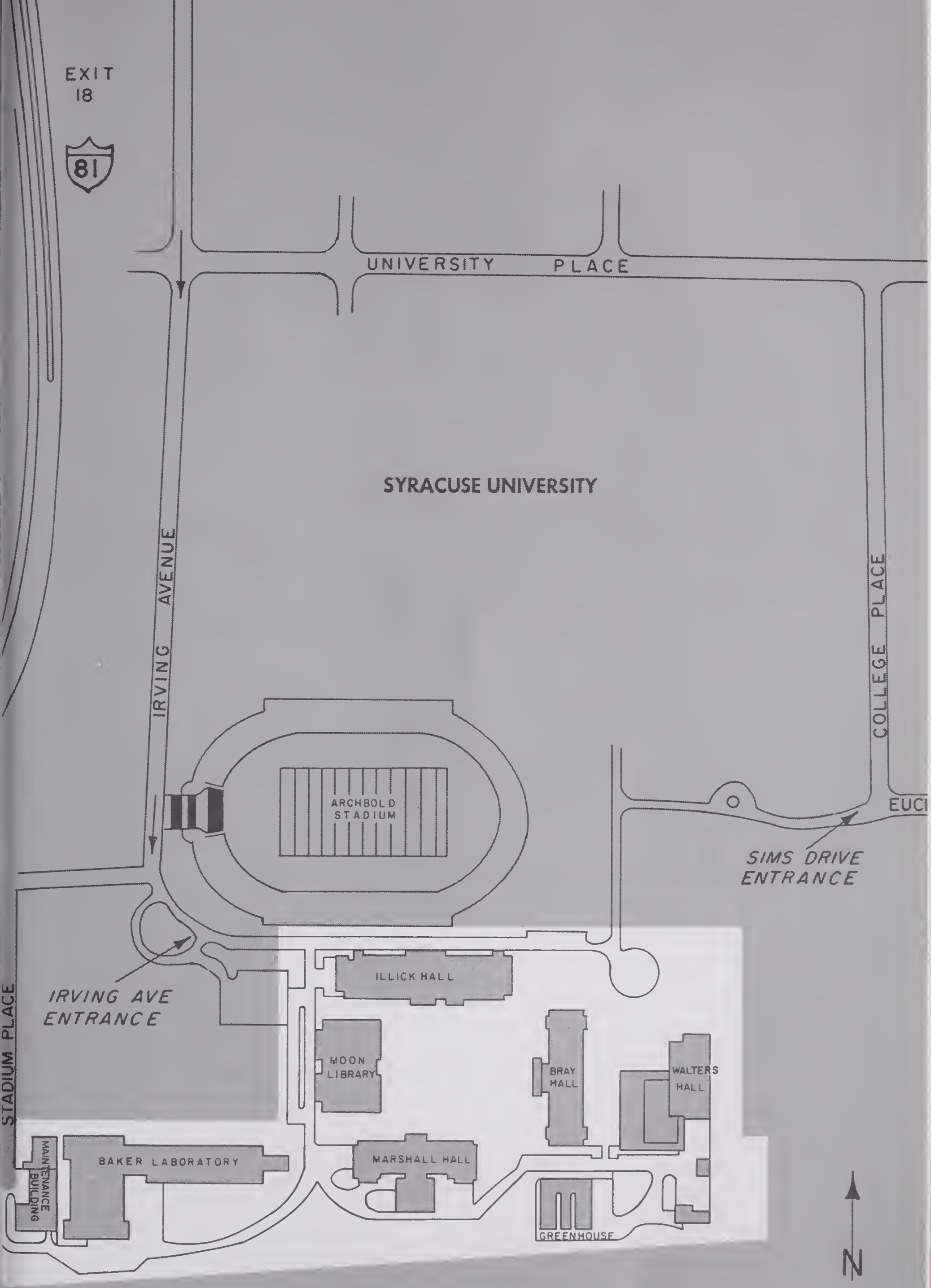
Index

Adirondack Ecological Center ... 18
Administration, College 92
Admission 27
-Requirements 27
-Advanced Tests 27
-Procedure 27
-International Students 28
AFRI 11
Applied Forestry Research Institute 11
Assistantships 31
Biology, Chemistry and Ecology, School of 39
Biology, Forest 67
Board of Trustees
-ESF 91
-SUNY 87
Botany 40, 68
Calendar, Academic 2
Campuses, Regional System of .. 15
Career Services 32
Chemistry 43, 70
Commencement Fee 29
Computer Center 17
Continuing Education 9, 84
Cooperative Research Unit, U.S. Forest Service 13
Correspondence Directory Inside Front Cover
Course Offerings 61
Cranberry Lake Campus 18
Degree Requirements 25
Degrees, Graduate 25
Economics, Forest 53
Educational Communications Unit 17
Ellis International Laboratory ... 18
Empire State Paper Research Institute 12
ESPRI 12
Employment, Part-Time 32
Engineering 44
-Forest Engineering 45, 64
-Paper Science and Engineering 46
-Wood Products Engineering ... 47
Entomology 41, 73
Environmental and Resource Engineering 64
Environmental and Resource Engineering, School of 44
Environmental and Resource Management, School of 48
Environmental Assessment 38
Environmental Communications 37, 54
Environmental Science 35, 63
Expenses, Student 29
Experiment Station 18
Faculty, College 93
Faculty, Emeritus 105
Fellowships 31
Financial Assistance 31
Forest Biology 67
Forest Engineering 45, 64
Forest Entomology 41, 73
Forest Influences 48, 55
Forest Pathology 40, 68

Forest Service, U.S. 13
Forest Soil Science 56
Forest Technology, School of 17
Forest Zoology 42, 75
Genetic Field Station 18
Grants-In-Aid, SUNY 32
Heiberg Memorial Forest 17
History and Traditions, College .. 5
Housing, Student 29
Huntington Wildlife Forest 18
Institute of Environmental
Program Affairs 11
IEPA 11
Instruction 8
-Continuing Education 9
-Graduate 8, 23
-Professional 8
-Technical 8
International Students 28
Landscape Architecture 58, 77
Landscape Architecture,
School of 58
Land Use Planning 38, 53
Loans, Educational 32
Management 52
Managerial Science and Policy ... 48
Map and Locator, Campus 110
Mathematics, Applied 62
Mission, College 8
Moon Library, F. Franklin 16
Newcomb Campus 18
Organic Materials Science 36
Pack Demonstration Forest, C.L. . 18
Paper Science and Engineering 46, 64
Pathology, Forest 40, 68
Policy and Administration 52
Polymer Center, SUNY 12
Professional Staff 93
Public Service 13
Quantitative Methods 53
Recreation Management 52
Remote Sensing 37
Research 10
Resource Management and
Policy 49, 80
Silvics 55
Silviculture 48, 55, 84
Soil Science, Forest 56
State University of New York 87
Syracuse Campus, ESF 15
Syracuse Metropolitan Area 21
Syracuse University 6, 35, 61
Tree Improvement 57
Tuition and Fees 29
Tuition Assistance Program 32
Tuition Waiver Scholarships 31
Tully Campus 17
Ultrastructure Studies Laboratory,
N.C. Brown 13
Upstate Medical Center, SUNY .. 61
Wanakena Campus 17
Warrensburg Campus 17
Water Resources 38
Wood Products Engineering .. 47, 64
Work-Study Program 32
World Forestry 57
Zoology, Forest 42, 75

Campus Locator

Admissions	110 Bray
Affirmative Action	110 Bray
Alumni/Development	121 Bray
Analytical and Technical Services	139 Baker
Applied Forestry Research Institute	6 Moon
Assistant Vice President for Academic Programs	200 Bray
Assistant Vice President for Research	200 Bray
Audio-tutorial Center	16 Moon
Business and Fiscal Affairs	102 Bray
Career Services	107 Bray
Cellulose Research Institute	314 Baker
Community Relations	123 Bray
Computer Services	320 Baker
Counseling Services	107 Bray
Educational Communications	302 Illick
Empire State College	114 Walters
Empire State Paper Research Institute	317 Walters
Facilities	Maintenance Building
Film Library	9 Moon
Financial Aids	111 Bray
International Forestry	319 Bray
Institute of Environmental Program Affairs	200 Bray
Institutional Research	206 Bray
Library	101 Moon
Maintenance and Operations	Maintenance Building
Personnel	224 Bray
President	204 Bray
Publications	100 Bray
Registrar	113 Bray
School of Biology, Chemistry and Ecology	311 Baker
School of Continuing Education	231 Baker
School of Environmental and Resource Engineering	208 Walters
School of Environmental and Resource Management	319 Bray
School of Landscape Architecture	331 Marshall
Security and Safety	8 Bray
Student Council	18 Moon
SUNY Polymer Research Center	216 Baker
Ultrastructure Studies Center	417 Baker
U.S. Forest Service Cooperative Research Unit	106 Marshall
Veterans' Affairs	107 Bray
Vice President for Administration and Services	208 Bray
Vice President for Program Affairs	227 Bray
Vice President for Student Affairs	107 Bray
Wood Utilization Service, Applied Forestry Research Institute	13 Moon



COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

THE STATE UNIVERSITY OF NEW YORK
COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY
SYRACUSE, NEW YORK 13210

1978 - 79
Graduate Studies

SUNY
COLLEGE OF
ENVIRONMENTAL SCIENCE
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State University of New York

COLLEGE OF

ENVIRONMENTAL SCIENCE AND FORESTRY

1978 - 79

Graduate Studies Bulletin

TABLE OF CONTENTS

Academic Calendars	2
ESF: What's In A Name?	5
The Mission: Instruction, Research, Public Service	8
The Campuses	15
The Syracuse Metropolitan Area	21
Graduate Study At ESF	23
Requirements For Degrees	25
Admission	27
Expenses	29
Financial Assistance	33
Graduate Degree Programs	35
Graduate Exchange Programs	65
Course Offerings	67
State University of New York	91
College Trustees And Administration	94
College Faculty And Professional Staff	96
Index	110
Campus Locator And Map	112

Academic Calendar

SYRACUSE CAMPUS

FALL 1978

Registration	September 6-7	Wednesday-Thursday
First Day of Classes	September 8	Friday
Rosh Hashana	October 2	Monday
Yom Kippur (no classes)	October 11	Wednesday
Thanksgiving Vacation	November 22-26	Wednesday-Sunday
Last Day of Classes	December 15	Friday
Exam Period	December 18-22	Monday-Friday

SPRING 1979

Registration	January 15-16	Monday-Tuesday
First Day of Classes	January 17	Wednesday
Spring Recess	March 10-18	Saturday-Sunday
Last Day of Classes	May 1	Tuesday
Reading Day	May 2	Wednesday
Exam Period	May 3-9	Thursday-Wednesday
Commencement	May 12	Saturday

ESF: What's In A Name?

1911. Governor John A. Dix signed a bill establishing the New York State College of Forestry at Syracuse University.

1948. Legislative action incorporated into State University of New York all state-supported higher education. Thus, the State University College of Forestry at Syracuse University.

1972. By special legislative act, the College was renamed the State University of New York College of Environmental Science and Forestry.

Why, in the first place, all the name changes? And, secondly, what difference do they make? What, really, is in our name?

ESTABLISHING A TRADITION

While a professional forestry education in this country is almost entirely a development of the twentieth century, its primary roots can be traced back as early as 1862 when Congress passed the Morrill Act establishing a system of land-grant colleges.

The growing importance of forests in America's economy was reflected in the 1870 Census, when, for the first time, information on forest resources was included. Several attempts to establish a national school of forestry were made; while none was approved, the movement shows that there was considerable demand for professionally trained foresters.

By 1900 there was a spirit of reform in the country—the same spirit that produced the early muckrakers also produced a generation interested in the conservation, preservation and careful management of precious natural resources. Between 1903 and 1914, 21 schools of forestry were established.

The first college of forestry in this country to offer a full, four-year undergraduate program was established in 1898 at Cornell University. Under the leadership of Bernard E. Fernow, students were introduced to critical field experience in their junior and senior years at the college's 30,000-acre forest in the Adirondacks. There, Fernow taught many experimental management practices, including clear-cutting and surface-burning. These techniques have always been controversial, and they aroused criticism by the wealthy summer residents in adjacent areas of the Adirondacks. After only five years of operation, the Cornell College of Forestry was closed in 1903 when the State Legislature, yielding to the influential property owners, ended fiscal support.

The beginnings and early development of the New York State College of Forestry were largely due to James R. Day, Chancellor of Syracuse University, and community leaders who were attuned to the growing national sentiment favoring forest conservation and who sensed the need for a professional school of forestry. The legislative act which created the College instructed that the institution "conduct such special research in State-wide investigations in forestry as will throw light upon and help in the solution of forestry problems. . ." and that it be "the institution for educational work in forestry in the State."

From the very first years of its existence under the first dean, Hugh P. Baker, the College responded to the broad needs of environmental professionalism. While other schools and colleges of forestry became more specialized, the College at Syracuse broadened to include the essentials of environmental science: design, engineering and the life sciences, as well as resource management.

BROADENING THE BASE

With the formation of the State University of New York in 1948, coordination and systematization came to higher education in the state. The University, according to its charter, was to "supplement, not supplant, the great network of private colleges and universities." The College of Forestry which, from its beginning had been state-supported and governed by a Board of Trustees currently made up of nine members appointed by the Governor and six *ex-officio* members, was recognized as a specialized college within the State University system.

Stemming from Chancellor Day's early sponsorship of the College, Syracuse University and ESF have long been engaged in numerous fruitful devices of institutional cooperation. This relationship is probably the most outstanding example in this country of collaboration between public and private institutions of higher education. Even as a part of State University, the College maintains this unique position. The major character of the relationship stems from the fact that for more than 60 years the College purchased from Syracuse University the major portion of its supportive and enrichment instruction, thus allowing the College to more fully develop its professional upper division and graduate level instruction.

Other cooperative areas are living centers and dining facilities, athletic programs, the use of the University's infirmary and health counseling services, the bookstore facilities, the University library system and participation in numerous social activities including the elaborate religious, dramatic and cultural benefits of a large university.

ESF TODAY

The third phase in the evolvement of the College's name came in 1972 when it was rechartered as the State University of New York College of Environmental Science and Forestry. Thus, the name reflects more deeply the traditional grounding and concern of forestry in the environment; it illuminates more clearly the capabilities of its program.

The College of Environmental Science and Forestry has completed a plan, conceived more than 10 years ago, to achieve complete upper division/graduate status. Students wishing to embark upon a career in the

environmental sciences and forestry will enroll for two years at a junior college or four-year institution, studying an ESF prescribed math/science program and transfer to this college as juniors. The move to upper division/graduate college status marks another step in the College's long-standing commitment to educate professionals capable of facing the complex environmental problems of today and of the future.

For over 60 years, the full thrust of the State University of New York College of Environmental Science and Forestry has been focused on the environment on all of its six campuses and in each of its three mission areas—instruction, research and public service. The College has been, and continues to be, devoted to the advancement of environmental science and forestry.

The Mission: Instruction, Research, and Public Service

INSTRUCTION

Undergraduate Education

In the Fall of 1977, student enrollment reached 1,918. Of this number, 1,550 were undergraduates and 368 were graduate students. In addition, there were 25 students engaged in postdoctoral work.

At the baccalaureate level, the College offers professional study in seven four-year curricula: *biology, chemistry* (with options in biochemistry and natural products, environmental chemistry or natural and synthetic polymer chemistry); *forest engineering, paper science and engineering, wood products engineering* (with options in building construction or forest products), *resource management*, and *landscape architecture*. These programs are registered with the New York State Education Department.

Each of these curricula leads to the bachelor of science degree. In the case of landscape architecture, an additional year of study results in a bachelor of landscape architecture degree, and in the forest engineering program, a fifth year leading to a bachelor's degree in civil engineering can be taken at Syracuse University or State University at Buffalo.

Graduate Education

The College awarded its first graduate degree in 1913. Today the College offers advanced degrees in seven major program areas: *environmental and forest biology, chemistry, resource management and policy, silviculture and forest influences, environmental and resource engineering, landscape architecture, and environmental science.* These programs are registered with the New York State Education Department.

Graduate study leads to the master of science degree, the master of landscape architecture degree, and the doctor of philosophy degree. A postdoctoral study program, closely related to the College's research effort, is also available.

Technical Education

At the paraprofessional level, the College has been training forest technicians since 1912 at its Wanakena Campus in the Adirondack

Mountains. It is the oldest Ranger School in the United States.

In 1973, a two-year *forest technology* curriculum replaced the one-year certificate program. Graduates are awarded an associate in applied science degree. In the new curriculum, students take their first year of general education at an accredited 2- or 4-year college. The second year, with its emphasis on practical field training in the relationships between forest technology and managerial needs, is taken at Wanakena with its 2,800 acres of forested land. Graduates of this degree program in practical forestry are prepared for positions as forest rangers, federal, state and private industry forest technicians and forestry aides, company district forest supervisors, timber inventory specialists, timber sales supervisors, forest surveyors and engineering aides, and forest protection technicians.

Continuing Education

The philosophy that education is a lifelong pursuit is an ancient one and was written into the law creating the College. This concept is doubly important to the sciences and professions in this technological age when, with new knowledge bursting in all directions, major environmental problems still remain to be resolved. The informational needs of New York's citizens also are undergoing change. The increasing urban character of our population, the changing pattern of agricultural and forest land ownership and use, the rise in level of education and sophistication in a more efficient society, and the increase in leisure time, travel mobility and need for recreational facilities and pursuits all contribute to a growing need for educational opportunities in environmental science and forestry for adult audiences.

The College has, over the years, succeeded in communicating knowledge on forest resources management, utilization and conservation to a variety of off-campus publics. The entire College faculty has contributed to these programs. To reinforce this commitment, the College established a School of Continuing Education upon which to base expanded educational opportunities at both the undergraduate and graduate course levels.

Conferences, symposia, seminars and short courses on various aspects of forestry and the related sciences are conducted at both the basic and applied levels. Audiences include forest owners, managers and operators, wood engineers and forest industries personnel, academic and scientific groups, conservation and recreation personnel from local and other public and private planning groups and citizen-action committees. Upon request, continuing education programs can be designed to meet specific needs of professional organizations, agencies and industry. Credit or noncredit courses, at campus or off-campus sites, can be arranged.

Expansion of "in-service" training courses, establishment of "environmental learning centers" on College forest properties and production of media materials for public information and education are examples of activities directed toward updating and upgrading professional clients and broadening the public's awareness and appreciation of New York's forest-lands and other natural resources.

For information on specific continuing education projects, inquiries should be sent to Dean, School of Continuing Education.

RESEARCH

The College's commitment to scientific inquiry stretches far back to its second year of existence. In 1912, Dean Hugh P. Baker initiated the first research project of the College by joining forces with the U.S. Forest Service in an industry study designed to show what kinds of firms were using wood in New York State and the species and quantities of lumber they used.

In the 1970's, the College's research program has attracted a worldwide clientele of industrial, governmental, professional and scientific groups; and through liaison with them, the program maintains its vigor and relevancy to the important environmental issues of the decade. Support from this clientele amounts to about $2.9 million a year.

Students and faculty from across the College contribute to the depth and diversity of the research program. Findings from these studies are applied to a host of issues and problems through various demonstrations and information devices. Recent examples include studies of limestone quarry reclamation; the development of polymeric materials for artificial human organs; nonchemical control measures for insect pests, e.g., the gypsy moth; studies of the ecology of Antarctic birds; and new wood pulping processes leading to pollution-free water and air effluents.

The Institute of Environmental Program Affairs

The Institute of Environmental Program Affairs (IEPA), created at the College in 1972, is an umbrella-like structure that coordinates the overall research effort of the College with the efforts of other academic institutions, public agencies and private industries for a concerted attack on compelling and complex environmental problems. IEPA culminates the College's ongoing examination of its appropriate role as a leader in environmental education for the 1970's and beyond in face of urgent appeals for multidisciplinary approaches, for problem-oriented task forces by both faculty and students, and for the greater application of higher education to society's needs. Because it is a process, the Institute preserves the identity of each collaborator: institutions, faculty members and students come together for just as long as necessary to solve a problem, then return to other ongoing areas of interest. Recent projects have included: resource and environmental studies for the St. Lawrence Eastern Ontario Commission, and the Tug Hill and Catskill study commissions; a study of wetlands evaluation systems for the Adirondack Park Agency; development of environmental impact assessment guidelines for the New York State Department of Environmental Conservation; a study of selected environmental impacts of possible nuclear power developments in New York State for the Argonne National Laboratory; and studies of the St. Lawrence River ecosystems and impacts of oil spills and extension of the shipping season for the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service, respectively.

Applied Forestry Research Institute

Much of the research being conducted at universities and institutes, while of value to long-range scientific study and technological progress, is of limited immediate application for forest practitioners. With this consideration, the Applied Forestry Research Institute (AFRI) was established in 1967 at the College with the cooperation of the New York State Department of Conservation. At the time of its founding, AFRI was charged with the task of carrying out research in the state that can be implemented at once by practicing foresters and forest resource managers.

The need for such research becomes more acute with time: the demands placed on the forest resource are ever increasing, and conservation groups are deeply concerned about the environmental impact of forestry's operations.

Research activities of AFRI include the environmental effects of forest practices, forest harvesting and forest products engineering, hardwood and conifer silviculture, forest pest and disease control, and multiple-use management planning.

There is close cooperation with the College's highly competent teaching-research faculty who provide the latest information about basic research findings by disciplines as well as supporting technical information and techniques. This liaison allows for the exchange of views between the academician and the field practitioner.

AFRI is supervised by a director, and has a staff of six full-time research associates and two technical assistants.

Empire State Paper Research Institute

The Empire State Paper Research Institute (ESPRI), located on the main campus, is the only worldwide basic research organization in the pulp and paper field. It performs investigations in cooperation with the Empire State Paper Research Association (ESPRA), which is comprised of 62 pulp and paper companies in 11 countries. The Institute was established in 1945 when the members of ESPRA recognized the need for new scientific and technical knowledge and methods, and since then ESPRI has been able to maintain an efficient balance between the practical and theoretical bases of the pulp and paper industry.

Housed in the modern J. Henry Walters Hall with its own pilot paper mill, and staffed by scientists who are internationally recognized for their accomplishments, ESPRI provides a research base for long-range industry development. Its program has widened in scope to cover almost all aspects of pulping and papermaking, including additive retention, oxygen pulping and bleaching, effluent control, sheet drying, printability, and energy efficiencies.

State University Polymer Center

In 1966 the College's polymer research institute was designated as the State University of New York Polymer Research Center in order to stimulate University-wide interest in polymer chemistry.

Scientists at the College have made many original contributions to the field of pure and applied polymer chemistry, including the development of living polymers, the study of anionic polymerization and electron-transfer initiation, and work on the permeation of gases and films through polymeric films.

College faculty members specializing in polymer chemistry have trained several hundred graduates and postdoctoral researchers, many of whom now hold leading positions in universities and industrial and governmental laboratories.

USDA—Forest Service Cooperative

The Northeast Forest Experiment Station of the USDA-Forest Service maintains a research center at the College. Until 1977, this unit pursued studies of forest centered recreation with the aim of developing improved methods for integrating recreation and other uses of forests.

Beginning in 1978, the Cooperative Research Unit will be re-oriented to research on urban environmental forestry problems. This will provide increased opportunities for faculty and students to collaborate with Forest Service scientists in studies of a variety of urban and environmental problems.

Nelson Cortlandt Brown Laboratory for Ultrastructure Studies

This center, located in Baker Laboratory, is a teaching, research and service facility of the College. It is equipped to handle virtually every type of modern microscopy operation, including light, scanning electron and transmission electron. Among the major items of equipment are: an RCA EMU-3 transmission electron microscope; an RCA EMU-4, an ETEC autoscan scanning electron microscope, energy dispersive X-ray analyzer, several types of light microscopes, high vacuum evaporators and microtomy equipment.

The primary service of the center is teaching; course offerings include microtechnique, photomicrography, electron microscopy and interpretation of cellular ultrastructure. A second function of the center is to provide research on a service basis to faculty and students and to the community at large.

Adirondack Ecological Center

The Adirondack Ecological Center (AEC) is located on the College's Newcomb Campus in the center of the Adirondack Mountains. Staffed by resident scientists, technicians, and support staff, the AEC conducts studies of the Adirondack region year round. Research includes studies of managed and unmanaged forest lands, wildlife populations and habitats, terrestrial and aquatic ecology, wilderness management, etc. Work is carried on in close collaboration with the New York State Department of Environmental Conservation, the U.S. Fish and Wildlife Service, the USDA, and forest industries.

The vigorous research program of the Center provides excellent opportunities for collaboration by Syracuse based faculty and students. Several graduate students are regularly in residence at Newcomb pursuing their thesis research.

PUBLIC SERVICE

The College, throughout its 67-year history, has continued to respond to its specific legislative mission prescribing major responsibilities in the area of public service. Public education and information, technical advice and guidance to cooperating local, state and federal agencies and organizations, and technical assistance to the forest and wood-using industries constitute the principal formal public service activities. The Institute of Environmental Program Affairs (described in the Research section) coordinates the College's public service activities on the professional level.

While the list of public service contributions is lengthy, a few examples include: the College's Film Library; the Tree Pest Service, which provides technical advice to private citizens and to governmental agencies; the participation of ESF faculty members in Central New York's Poison Control Center; and membership in PACE (Planning Approaches for Community Environments), a faculty-supervised student design and planning service to benefit community development. Altogether, the public service programs of the College reach approximately one million New York State residents each year.

The Campuses

The College operates a multiple campus system with regional campuses and field stations located at Syracuse, Tully, Wanakena, Warrensburg, Cranberry Lake, Newcomb and Clayton. This system is composed of about one million square feet of facilities in 179 buildings and 25,000 acres of land. Collectively, they represent the largest fully utilized campus in the world.

THE SYRACUSE CAMPUS

The main campus is in Syracuse, and lies on 12 acres adjacent to Syracuse University, in an area that traditionally has been known as "The Hill." Located here are the Schools of Biology, Chemistry and Ecology; Environmental and Resource Engineering; Environmental and Resource Management; Landscape Architecture; and Continuing Education. In addition, the main campus houses the Institute of Environmental Program Affairs, the Applied Forestry Research Institute, the Empire State Paper Research Institute, the State University Polymer Research Center, a cooperative research unit of the U.S. Forest Service, and an ultrastructure center.

These program units are housed in five major academic buildings (Baker Laboratory and Walters, Bray, Marshall and Illick Halls). The administrative headquarters of the College is located in Bray Hall. The main campus also embraces Moon Memorial Library, the Maintenance Building and several other small service and storage facilities.

Specialized facilities at the Syracuse campus include electron microscopes, plant growth chambers, air-conditioned greenhouses, an animal environmental simulating chamber, a bio-acoustical laboratory, a 1,000-curie cobalt-60 radiation source, radioisotope laboratory, computer center, and specialized instrumentation including nuclear magnetic resonance spectrometer, electron spin resonance spectrometer, mass spectrometer, ultracentrifuge, X-ray and infrared spectrophotometer. Photogrammatic and geodetic facilities of the forest engineering department include one of the most extensive arrays of equipment in the United States, with a Nistri TA-3 stereocomparator, Mann comparator, computerized Nistri photocartograph, and nine other varieties of plotters. The paper science and engineering laboratory has a semicommercial paper mill with accessory equipment. The wood products engineering department has a complete strength-of-materials laboratory as well as a pilot scale plywood laboratory and a machining laboratory. The greenhouses and forest insectary are used to produce plant and insect material for classroom and laboratory. Extensive collections are available for study, including wood samples from all over the world, botanical materials, insects, birds, mammals and fishes.

The **F. Franklin Moon Library** contains more than 71,000 cataloged items. Over 800 journals and corresponding indices are currently received.

The collections constitute an information center for forestry and environmental science programs in ecology, botany and pathology, biochemistry, chemical ecology, forest chemistry, polymer chemistry, economics, entomology, environmental studies, industrial pollution abatement, landscape architecture, environmental design, management, paper science and engineering, photogrammetry, silviculture, soil science, water resources, world forestry, wildlife biology, wood products engineering and zoology. These are supplemented by large collections in the environmental resource field. Additional strength is found in the comprehensiveness of abstract and indexing services relevant to the College's programs. The library also offers a selected and broad choice of general-interest reading material.

The collections of Syracuse University Libraries and State University Upstate Medical Center are within walking distance. They may be used by all members of the College of Environmental Science and Forestry. Arrangements often can be made to use industrial libraries in the Syracuse area. Other collections are accessible through the Inter-library loan privilege.

The library building, opened in 1968, can accommodate 132,000 volumes and can seat 575 persons. The main reading areas are in the center of the upper level surrounding open stacks, a current periodicals room, bibliographic center, individual study carrels and library staff offices. The archives, special collections, conference rooms, audiotutorial center and informal study rooms are located on the lower level.

The audiotutorial center provides facilities for study with nonbook materials. Slides and cassettes prepared as integral units of particular courses are held on reserve for use in the center. Materials are available for review on weekends, evenings and times when other facilities are closed.

Leisure reading material is distributed throughout the total collection which represent the Robin Hood and Raymond F. Crossman collections, and contain books on national and world social problems, humanities, education and popular books concerned with the environment. The archives consist of historical items relevant to the College and forestry developments in New York State. The special collections room contains rare and valuable books and folios.

Reference service, orientation and bibliographic instruction (Library Research 300) are provided by the librarians. Study guides, user aids and other such publications are prepared and distributed by the librarians as needed.

The **Educational Communications** unit directly supports the program areas of the College through development and application of media materials and methods for the classroom, for the presentation of research findings and for public service endeavors. These include television programming, slide/tape and motion picture production and photographic services. Other services to the College community include engineering, A-V equipment distribution, and maintenance and support functions. The Educational Communications staff also participates directly and actively in instructional programs in environmental communication at both the undergraduate and graduate levels as well as through the School of Continuing Education.

The College **Computer Center** provides computational service via terminals connected to the Syracuse University academic computer facilities. Two computer systems are accessible—An IBM-370 model 155 used for batch processing and APL, and a large Digital Equipment Corporation DEC-KL10 used primarily for timesharing applications. Computer usage can be classified into academic and administrative categories with the academic use amounting to 80 percent of the total College load. The major academic use is in the graduate programs where students investigate problems in areas such as hydrology, transportation networks, forest and tree growth studies, genetics, disease and insect behavior and controls, land use, production and processing techniques, polymer and cellulose chemistry, cellular ultrastructure, photogrammetry and remote sensing, landscape architecture, and other related and supporting fields.

THE TULLY CAMPUS

Located about twenty-five miles south of Syracuse is the Tully Campus which is composed of the Heiberg Memorial Forest and the Genetic Field Station.

Heiberg Memorial Forest is located on the northern escarpment of the Allegheny Plateau in New York. It includes 3,800 acres of diverse terrain and forest growth. The Forest is utilized both as an extensive outdoor teaching laboratory and as a site for intensive research. The Forest Ecosystem Lab, which is a highly instrumented outdoor teaching laboratory; a large complex of all-weather classrooms; many experimental plantings, some from known seed sources from throughout the world; a commercial-scale maple syrup operation; and an experimental deer research area are among the developments on this forest. Each fall the Heiberg Memorial Forest is the site of an intensive program for environmental and resource management students in a total ecosystem approach to forest community management instruction.

The **Genetic Field Station** is located adjacent to the Village of Tully, New York. It is in a particularly fertile area and is devoted to relatively short-term outplantings of plant materials developed in the various genetics research projects of the College.

THE WANAKENA CAMPUS

The Wanakena Campus is located on the Oswegatchie River, 65 miles northeast of Watertown, New York, and 35 miles west of Tupper Lake, New York. This campus, with its large instructional and demonstration forest, supports the College's **School of Forest Technology**, the oldest forest technician school in the country. It is on this campus that forest technicians are trained in an associate degree program.

THE WARRENSBURG CAMPUS

The Warrensburg Campus is located in the southeastern Adirondack region and encompasses the Charles Lathrop Pack Demonstration Forest,

an area of roughly 2,500 acres of heavily forested land noted for its white pine. The Forest has been under intensive management since 1927 for the combined purpose of instruction, research and demonstration in forestry and allied fields.

Each week this campus hosts the Summer Session in Field Forestry, a five-week course devoted to introductory instruction in field forestry principles and techniques. The course is required of all entering students in Environmental and Resource Management and is open to election by students in Environmental and Forest Biology. Formal offerings in Continuing Education and various meetings and conferences are also held here for practicing professionals and organizations directly associated with forestry and allied environmental fields.

THE CRANBERRY LAKE CAMPUS

The Cranberry Lake Campus, accessible only by water, is the site of the College's biological station, where, every year, a cooperative program in environmental biology is sponsored jointly by the College and other institutions of higher education. Bounded by 150,000 acres of forest preserve, by Cranberry Lake, and by isolated forest bogs and beaver meadows, the extensive facilities are intensely utilized in a comprehensive curriculum of upper-level and graduate courses.

THE NEWCOMB CAMPUS

Located in the central Adirondack Mountains, Newcomb is the largest of the regional campuses and home to the **Adirondack Ecological Center** where extensive studies of animal biology and ecology are carried out. Located there also is **The Archer and Anna Huntington Wildlife Forest**.

THE FIELD STATIONS

In addition to its Regional Campus System, the College operates several field stations which directly support the programs of the institution. The 44-acre **Forest Experiment Station**, located only a few minutes drive from the main campus, is used to support main campus academic programs. Located at the Station are a large arboretum, tree nursery and experimental greenhouse facility. Adjacent to the Tully Campus is the College's **Genetic Field Station**. With its irrigation system and layout of level blocks, it is an excellent facility for developing hybrids, for grafting experiments, and for research in heritability. A magnificent island, the **Ellis International Laboratory**, is situated in the heart of the Thousand Islands-St. Lawrence River area off the village of Clayton. Accessible only by water, this laboratory, which is the College's most recent property acquisition, is an unusually appropriate site for the College-wide, cooperative and international environmental monitoring and research activities.






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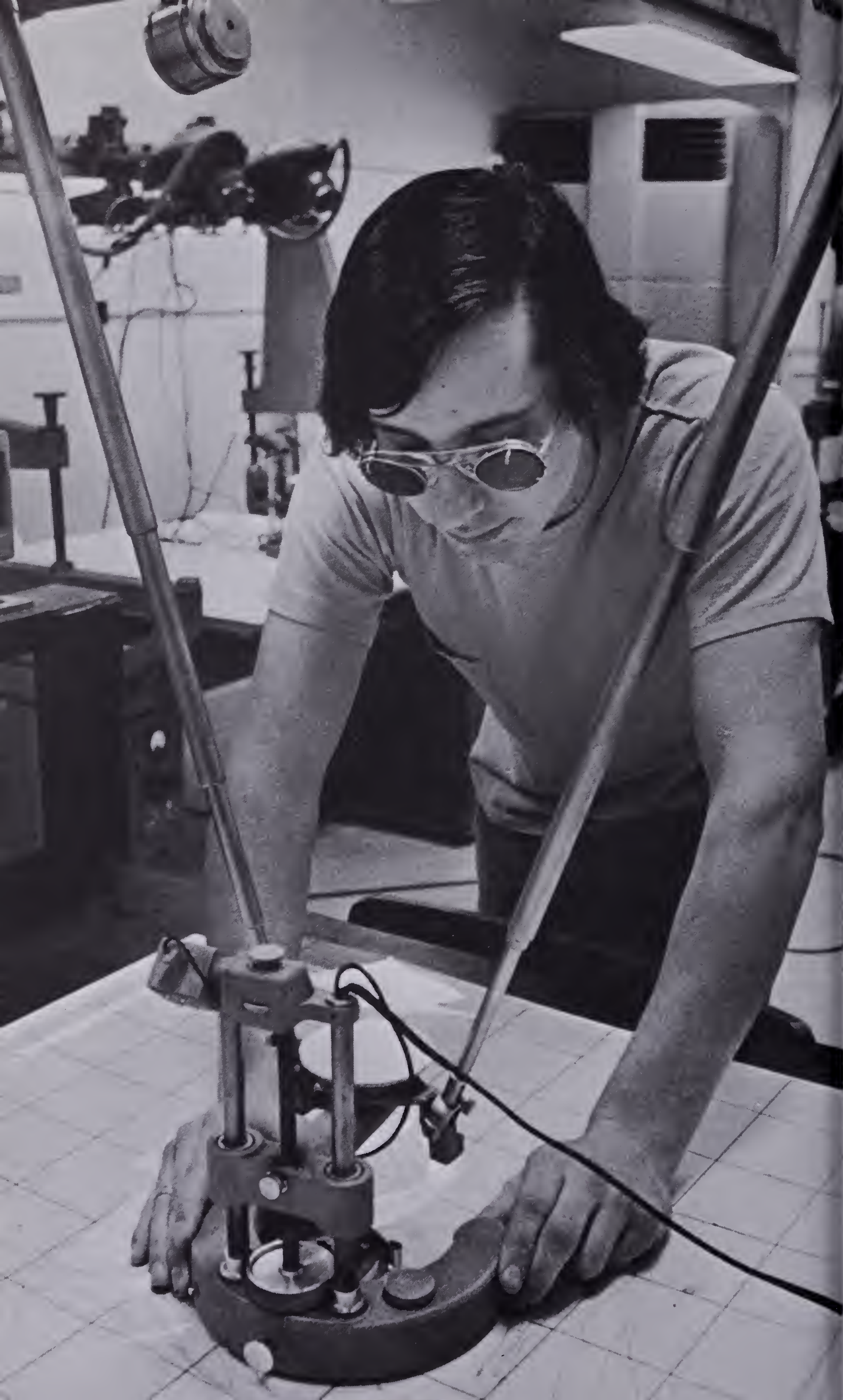
OUR SPECIALTY

The Syracuse Metropolitan Area

The College of Environmental Science and Forestry is located on one of several hills that overlooks Syracuse, a growing metropolitan area of nearly 500,000. Known as the "Salt City" because of the great salt industry which was centered here for more than seventy years, Syracuse is today a city of diversified industry and commerce. The area is a leader in the manufacture of china, quality shoes, air-conditioning equipment, medical diagnostic equipment and decorative home accessories.

The City of Syracuse offers students many cultural, recreational and educational opportunities, including a symphony orchestra, several museums, live theater and historical points of interest.

Called the "Crossroads of New York State," Syracuse is one of the few cities in the nation situated at the crossing point of two major superhighways. It is located at the intersection of the 500-mile east-west New York State Thruway and the north-south Penn-Can Highway. Driving time from New York City, Philadelphia, Boston, Toronto and Montreal is about five hours; from Buffalo and Albany about three hours. The city is served also by a modern international airport and major bus and rail lines.



Graduate Study at ESF

Society is increasingly in the hands of those who have broad foresight and a balance of judgment in applying sociological and technical knowledge to guide human and environmental forces. Modern civilization—with its compelling demands from industry, government and educational institutions—requires people who think objectively and constructively, and who act creatively and responsibly.

A purpose of the graduate years is to develop these persons. These years are a time of discovery and excitement, a time of answers and new insights, a time of personal productivity and contributions to scholarship. It is during the graduate education that the student sharpens the ability to think critically and analytically, to plan research, to design experiments, to work effectively with the basic research tools as well as specialized equipment, and to undertake the discipline of purposeful study toward a specific goal.

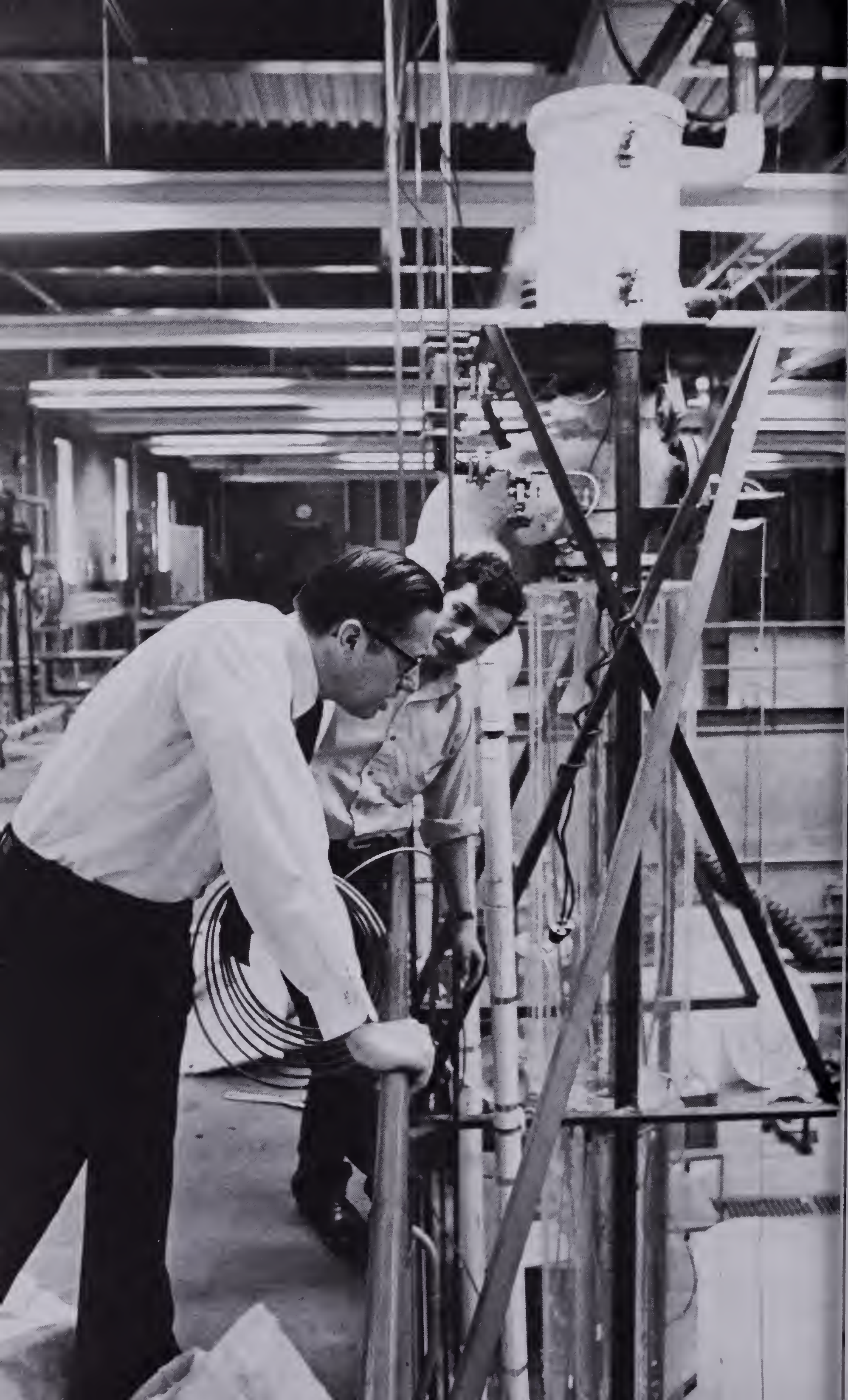
From its beginnings in 1911, the State University of New York College of Environmental Science and Forestry has served New York State and the nation in meeting the needs of its citizens in regard to the environment through education, research and public service. The faculty and students of the institution are committed to the resolution of immediate environmental problems, the development of the knowledge necessary to predict occurrences in the future, and the presentation of public policy alternatives that will both protect the environment and accommodate the real needs of society.

The major impetus for this inquiry lies in the research programs of the College in which the graduate students play an integral role with the faculty. The College has more than 150 faculty whose research interests in various aspects of environmental science involve more than 300 graduate students in master and doctoral degree programs.

The College currently supports significant graduate degree programs in six subject areas and, in addition, its broad program in Environmental Science encourages the development of multidisciplinary graduate research in several study areas.

The diversity and depth of the graduate programs of the College reflect the work of its excellent faculty and their graduate student colleagues utilizing some of the most modern facilities and laboratories in the country. They maintain a long-standing tradition of academic and professional excellence.

This bulletin provides an introduction to the College and its programs of graduate study and research. It only begins to suggest the diversity and depth of the existing and potential programs that make environmental science the *challenge of the 70's* and beyond.



Requirements for Degrees

Graduate programs are flexible and developed individually. Each program is planned by the major professor with the student to meet the individual's particular academic and professional needs. Sometimes this includes undergraduate courses for which no graduate credit can be given. In every case, emphasis is placed on outlining a study program leading to a high level of scholarly achievement.

An entire program for each student is planned and must be approved by the major professor, department chairman and school dean. The program is modified as required upon recommendation of the major professor. A thesis committee composed of the major professor and two other faculty members is appointed early in each student's study program. In some departments, all graduate students are required to engage in an appropriate teaching assignment as an academic degree requirement.

THE MASTER'S DEGREE

All programs leading to the Master of Science (MS) and Master of Landscape Architecture (MLA) degrees require at least 30 semester hours of graduate credit and two semesters in residence. From 6 to 18 hours of graduate credit may be earned through completion of a thesis or special project. The remaining credit hours are earned through completion of course work (passed with an average grade of B, or better). A total of at least 15 hours of credit, including thesis and special project credits, must be in courses numbered at the 600 level or above.

Students must also pass a final oral examination defending the thesis and demonstrating knowledge of related subject areas. Acceptance of the thesis or special project requires a clear demonstration of ability to evaluate pertinent literature, to plan and execute an independent investigation, to interpret the significance of findings and to report the foregoing in a well-organized and lucid manner.

DOCTOR OF PHILOSOPHY DEGREE

In pursuing the Ph.D. degree, the student is required to work on the frontiers of knowledge in a particular field of study and to make a contribution to this knowledge. This is accomplished through original study including the search and evaluation of literature; the conception, planning, execution, and interpretation of high quality research; and the presentation of the above in a well-organized and well-written dissertation. Subsequent publication of research findings in an appropriate journal is expected.

There is no minimum credit hour requirement for the Ph.D. Each student must pass a qualifying examination before being admitted to candidacy. This two-part examination consists of a preliminary examination taken early in the period of residence to assist in planning a course work and independent study program, and a written and oral comprehensive examination to test breadth and depth of knowledge. There is no College-wide language requirement. However, competence in a foreign language, statistics, computer programming or other "tools" may be required where they are relevant to the student's field of study. Students seeking the Ph.D. degree must be in residence for at least two semesters, and must matriculate for a minimum of three academic years. The final requirement is the presentation and defense of the thesis or dissertation.

Admission

Admission to graduate study may be granted only to applicants with at least a bachelor's degree from a recognized institution, and whose preparation has been suitable in quality and content for the proposed field of major study. Applicants will be evaluated on the basis of the following: (1) their academic record should show at least a B or 80 percent average for the junior and senior years; (2) Graduate Record Examination Aptitude scores, and, in some cases, subject matter (advanced) tests indicative of graduate study ability (see below); (3) supporting letters of recommendation; (4) a statement of specific educational and professional goals which describes the choice of degree program and the student's plan for the pursuit of the objectives in the program; and (5) where appropriate, other evidence of scholarly achievement and potential. Admission is selective with priority given to applicants who have high scholastic standing.

ADVANCED TESTS

Subject matter (advanced) test scores are required by the following programs:

Graduate Programs	*Advanced Test*
Chemistry	Chemistry
Environmental and Forest Biology	Biology

PROCEDURE

All applicants are required to submit Graduate Record Examination aptitude scores. This examination is offered several times each year in major cities of the world. For information on registration and scheduling write to the Educational Testing Service, Princeton, New Jersey 08540. Test scores should be sent to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210 (Institutional number R2530).

The College provides a special form for application for graduate work. Requests for information and applications should be addressed to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

INTERNATIONAL STUDENTS

Citizens of other countries with special educational objectives are accepted for graduate study in all programs. They must show satisfactory evidence that they have completed studies in their major field equivalent to those at a recognized American institution with a scholastic record equivalent to a B average in their junior and senior years. They must submit Graduate Record Examination scores as explained in the section on Admission Requirements. Also, applicants whose native language is other than English must submit scores on the Test of English as a Foreign Language (TOEFL). This requirement may be waived if the student has received a degree from an American institution. This examination is offered several times each year in major cities of the world.

For information on registration and scheduling, write to the Educational Testing Service, Princeton, New Jersey 08540, U.S.A. In submitting test scores, request that they be sent to the Office of Academic Programs, State University of New York College of Environmental Science and Forestry, Syracuse, New York 13210.

Expenses

TUITION AND FEES

The tuition and fee structure at the College of Environmental Science and Forestry covers usage of library, infirmary, physical education facilities, ROTC, special testing and other services, as well as an assessment for student activities and charges for expendable supplies and equipment.

Tuition is charged at the following rate per semester:

Matriculated Graduate Student	New York State Resident	Out of State Resident
Full-Time	$700	$900
Part-Time	$58.50/credit hour	$75/credit hour
Nondegree student who does not hold a Baccalaureate degree		
Courses numbered:		
500-599	$30/credit hour	$50/credit hour
600-999	$58.50/credit hour	$75/credit hour
Nondegree student who holds a Baccalaureate degree		
500-999	$58.50/credit hour	$75/credit hour

STUDENT ACTIVITY FEE

In addition to tuition, the graduate students have voted to assess each graduate student $28 per year ($7.50 for those beginning in the Spring semester) to cover the cost of activities at both ESF and Syracuse University. This amount includes an optional yearly fee of $3 which supports Syracuse University's Public Interest Research Group (PIRG).

OTHER FEES

There is a General College Fee of $25 per year for all full-time students. In addition, all students pay a $20 per year State University Health Services fee.

COMMENCEMENT FEE

Candidates for both master's degrees and doctoral degrees pay a $10 commencement fee. Additional costs are incurred for the binding, abstracting, and microfilming of theses.

TERMS OF PAYMENT

A check or money order for tuition and fees should be made payable to State University of New York College of Environmental Science and Forestry. This payment is required by the last day of the registration period and can be paid at the College's Business Office either prior to registration or during registration. A fee of $10 is charged for registering later than the established dates.

HOUSING

The College does not operate student residences. These facilities are offered by Syracuse University, and cost varies according to the type of room or apartment. Furnished and unfurnished apartments for single graduate students and for married graduate students and their families are located on the South Campus, approximately two miles from the Main Campus, and are serviced by a regular shuttle-bus.

Any student who wishes to live in Syracuse University housing should write to the Director, Office of Residential Life, Steele Hall, Syracuse University, Syracuse, New York 13210. Formal admission to graduate study is required before such requests are acted upon.

In addition, a wide variety of living arrangements in private homes and apartment complexes is available in the metropolitan Syracuse area.

HEALTH AND ACCIDENT INSURANCE

All graduate students are required to have health and accident insurance. Graduate students who have funding through the State University Research Foundation may take the health and accident insurance available through the Foundation.

REFUNDS

The following policies apply to tuition liability and refunds for students canceling their registration.

A student who is given permission to cancel registration is liable for payment of tuition in accordance with the following schedule:

Liability During	*Semester*
1st week	0
2nd week	30%
3rd week	50%
4th week	70%
5th week	100%

Application for refund must be made within one year after the end of term for which the tuition was paid to State University. The first day of class session is considered the first day of the semester and Saturday of the week in which this first session occurs is considered the end of the first week for refund purposes. It is interpreted that a student who does not attend any class sessions after Saturday of the first week and who notifies the College of his intent to cancel registration on or before the second Saturday following the first day of classes will be considered to have canceled his registration during the first week.

There is no tuition or fee liability established for a student who withdraws to enter military service prior to the end of an academic term for those courses in which the student does not receive academic credit.

A student who is dismissed for academic or disciplinary reasons prior to the end of an academic term is liable for all tuition and fees due for that term.

A student who cancels registration at a unit of the State University and within the same term registers at another unit of the State University is entitled to full credit for tuition and fees paid for that term.

Notwithstanding any other provisions for refund, when a student has withdrawn through circumstances beyond the student's control, under conditions in which the denial of refund would cause undue hardship, the Chief Administrative Officer of the unit may, at his discretion, determine that no liability for tuition has been incurred by the student, provided the student has not completed more than one half of the term and has not received or will not receive academic credit for the term. Such action, including the reason for withdrawal, must be in writing.

Financial Assistance

The College awards a substantial number of assistantships and fellowships to qualified graduate students each year. The number of students receiving these awards varies from year to year, but usually more than half of all graduate students have received such support. In many cases it is not possible to provide a stipend at the start of the graduate study period, but such support is often provided after the student has demonstrated competence.

Students may indicate their interest in financial assistance on the graduate application form. Students on fellowships or assistantships must devote full-time to graduate study. Students seeking financial assistance should be sure their application and supporting documents reach the Office of Academic Programs before April 1, to ensure full consideration for an award for the fall semester.

GRADUATE ASSISTANTSHIPS

Assistantships are awarded to students of demonstrated scholarship and whose education and experience enables them to assist in laboratory instruction and research. The amounts of the assistantships range from $3161 to $5,000 per year. In addition, tuition is waived. Masters' students on assistantships must carry a minimum of 12 credit hours per semester, while Ph.D. students must carry at least 9 credits, and in some cases 12 credits, depending on their academic achievement beyond the baccalaureate degree.

SPECIAL FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships and assistantships sponsored by industries, associations and foundations are available in several departments. The amount of stipend varies. Holders of these special fellowships and assistantships usually confine the major part of their research activities to specified fields. Tuition is usually waived by the State University or provided by sponsors.

TUITION WAIVER SCHOLARSHIPS FOR INTERNATIONAL STUDENTS

Tuition waivers may be awarded to a limited number of international students judged to possess special academic capabilities and with demonstrated financial need, who are prepared to contribute to furthering international understanding and good will. Requests for such tuition waivers may be made on the graduate application form.

TUITION ASSISTANCE PROGRAM

Qualified New York State residents are eligible for Tuition Assistance Program grants which vary with the New York State net taxable income, and the level of study, and provide substantial reductions in tuition. For details and applications, contact the Director of Financial Aid at the College. (New York State residents holding graduate assistantships must apply to the Tuition Assistance Program in order to qualify for a graduate tuition waiver.)

LOANS

Graduate students may be eligible for various types of educational loans. The New York Higher Education Services Corporation offers loans to New York State residents of up to $5,000 per year. The current interest rate is 8 percent, and repayment begins 9 months after leaving college. Depending on income level, federal interest benefits may apply.

A graduate student who is a U.S. citizen may borrow up to $2,500 a year under the Student Loan Program of the National Defense Education Act of 1958. No interest will accrue until 9 months after leaving college, and then it is at 3 percent. A 10-year repayment period is allowed. For details and applications, contact the Director of Financial Aid at the College.

FEDERAL WORK-STUDY PROGRAM

The College also participates in the Federal Work-Study Program which is designed to enable students to partially defray their educational expenses through part-time jobs during the academic year. Applications and further information are available from the College's Office of Financial Aid.

Graduate Degree Programs

The College offers the Master of Science and Doctor of Philosophy degrees in the following programs:

SCHOOL OF BIOLOGY, CHEMISTRY AND ECOLOGY
Environmental and Forest Biology with areas of study in ecology, entomology, fish and wildlife biology and management, pathology and mycology, plant science, soil ecology, or zoology.

Chemistry with areas of study in polymers, natural products, biochemistry, or environmental chemistry.

Interdepartmental areas of study in chemical ecology or environmental biochemistry and physiology.

SCHOOL OF ENVIRONMENTAL AND RESOURCE ENGINEERING
Environmental and Resource Engineering with areas of study in forest engineering, paper science and engineering, or wood products engineering.

SCHOOL OF ENVIRONMENTAL AND RESOURCE MANAGEMENT
Resource Management and Policy with areas of study in forest management, recreation management, policy and administration, forestry economics, quantitative methods, land use planning, or environmental communications.

Silviculture and Forest Influences with areas of study in silvics, silviculture, forest soil science, tree improvement, or forest influences.

Interdepartmental areas of study in urban forestry or world forestry.

COLLEGE-WIDE PROGRAM
Graduate Program in Environmental Science with areas of study in environmental education/communication, environmental assessment and impact analysis, environmental land use planning, or water resources.

The College offers the Master of Landscape Architecture degree in the following program:

SCHOOL OF LANDSCAPE ARCHITECTURE
Landscape Architecture with areas of study in social/behavioral studies, natural/physical applied sciences, or design process, methods and management.

SCHOOL OF BIOLOGY, CHEMISTRY AND ECOLOGY

STUART W. TANENBAUM, Dean (Microbial Ecology and Metabolism)

The School of Biology, Chemistry and Ecology offers two curricula which support environmental science and forestry through the Department of Environmental and Forest Biology and the Department of Chemistry.

ENVIRONMENTAL AND FOREST BIOLOGY

JOHN B. SIMEONE, *Chairman* (Entomology, Chemical Ecology)

The Department of Environmental and Forest Biology encompasses a variety of interconnected disciplines which concern themselves with living systems. It treats not only the form, function and evolution of organisms, but their life requirements, tolerances and interactions that are central to the stewardship of renewable natural resources and the maintenance of an environment of acceptable quality. To achieve such goals, extensive knowledge of biology is basic. It is prerequisite to development of desirable practices and sound regulations for optimizing the use of our resources while, at the same time, avoiding deleterious impacts.

The academic program attempts not only to stimulate interest in the recognition and understanding of traditional organismal taxa such as plants, animals and protists, but deals as well with understanding the dynamic changes in biological systems which can be best ascertained in the context of the broad fields of ecology, physiology, evolution and genetics. This understanding is accomplished by an integration of coursework with a strong research program, much of which is concerned with natural resource management and improvement of the quality of man's environment.

The program is organized in nine interdependent biological study concentrations that provide comprehensive coverage within specific interest areas. Each concentration is governed by a faculty who defines the scope of subject matter, recommends acceptance of students and guides them in a course of study. Some of these concentrations follow taxonomic lines while others are broad unifying areas basic to all taxa; two include faculty of the Chemistry and Environmental and Forest Biology Departments. Students choosing to emphasize a taxonomic category should explore the desirability of engaging to some extent in the broader interdisciplinary areas. Similarly, it is often considered opportune for students enrolled in the latter to develop a degree of specialization in at least one taxon as a means of assuring a useful mix of talents. Those students whose interests are not served by the designated areas of concentration should explore the feasibility of alternate routes of study, provided the needed expertise is available, and they may be guided by faculty listed in the concentration nearest the student's interest.

Supportive to the program are the academic resources, including availability of courses, of Syracuse University, SUNY'S Upstate Medical Center and the several campus facilities described elsewhere in this catalog. Our students participate as well in courses and utilize faculty resources at Cornell University in cooperative exchanges. The major center of activity is Illick Hall, with the laboratories, classrooms, controlled spaces and equipment that one would expect in a modern, five-and one-half storied building in which 85,000 square feet of working space is available for graduate study and research. Laboratories, many of them temperature and temperature-humidity controlled and one sound-controlled, are provided for diverse study: plant development, physiology, tissue culture, biochemistry and toxicology, ecology, animal behavior, and similar endeavors. An herbarium, mycological collections, insect and other arthropod collections, and the Roosevelt Wildlife Collection of vertebrates are maintained in archival condition as useful resources for the academic program. Eight rooftop glasshouse units, three of them air-conditioned and one incorporated into a five-room indoor-outdoor insectary, are important to the full array of interests in plant science and plant-animal interactions.

Also of interest to the Department's students and faculty is the availability of a variety of sophisticated instrumentation. There is convenient access to a computer center; radio-isotope counting equipment, including liquid scintillation spectrometer and Cobalt-60 source; diverse analytical equipment and measuring devices; gas-liquid chromatography; and, in collaboration with the Chemistry Department, a comprehensive analytical expertise. The Nelson C. Brown Center for Ultrastructure offers scanning and transmission electron microscopy capability.

Excellent field sites and facilities are available for research in all aspects of the program in nearby or moderately distant locations from the Syracuse campus. In addition to the College's several campuses and field stations that offer a broad diversity of forest types, sites and conditions, there are New York State Department of Environmental Conservation lands, Montezuma National Wildlife Refuge, the Adirondack Mountains and the transition zones near Lake Ontario, Oneida Lake and Cicero Swamp that collectively offer a variety of habitat diversity from highlands to aquatic-terrestrial zones. The ponds, streams and lakes in Central New York and the St. Lawrence River are regularly used by graduate students in wetlands and aquatic ecology and fishery biology.

Further academic advantages stem from the urban setting of the Syracuse campus. The Greater Syracuse area provides a convenient laboratory for studies basic to urban forestry: the growth and protection of woody vegetation, greenspace maintenance, the utilization of waste beds for plant growth, the detoxification of pollutants and the restoration of terrain stripped of vegetation. Disposal of industrial and human pollutants and wastes requires deeper understanding of the role of plants, animals and microorganisms in the biodegradation of organic matter. The conversion of organic materials into useful fuel, into additives for plant growth or into protein feeds for domestic animals, to name a few, are stimulating study-in-depth of many elements of basic biology while at the same time offering substantial assistance toward the solution of pressing human problems.

Of the nine available study concentrations, seven are contained within the Department: *Ecology, Entomology, Fish and Wildlife Biology and Management, Pathology and Mycology, Plant Science, Soil Ecology* and *Zoology*. The two remaining concentrations are shared with faculty of the Chemistry Department: *Chemical Ecology* and *Environmental Biochemistry and Physiology*.

Ecology

ALEXANDER (Vertebrates, Wetlands), ALLEN (Forest Insects), BEHREND (Wildlife), BROCKE (Wildlife, Bioenergetics), CHAMBERS (Wildlife), DINDAL (Invertebrates), GEIS (Plants, Wetlands), KETCHLEDGE (Dendrology, Bryology), KURCZEWSKI (Insect Behavior), MITCHELL (Invertebrates, Bioenergetics), MORRIS (Diptera), MULLER-SCHWARZE (Vertebrates, Behavior), RAYNAL (Higher Plants, Taxonomy), RINGLER (Fishery Biology), SCHAEDLE (Plant Growth, Development), SIMEONE (Forest and Wood-boring Insects), TIERSON (Wildlife), VANDRUFF (Wildlife), WERNER (Limnology).

Understanding relationships between living organisms and their abiotic and biotic environment is fundamental to environmental science which also encompasses man's role in ecological systems. Ecology is an integrative science which depends on an understanding of ecological theory, habitat characteristics, and the basic biological attributes of organisms. This concentration area encourages the incorporation of this knowledge into those areas of practical concern. Specific research may entail the study of: distribution and abundance of organisms; community structure including trophic relationships, diversity or succession; and ecosystem properties such as patterns of energy transfer and biogeochemical cycling.

Entomology

ALLEN (Forest Insects, Population Ecology), BREZNER (Physiology), KURCZEWSKI (Morphology, Taxonomy, Behavior), LANIER (Forest Insects, Pheromones, Cytotaxonomy), NAKATSUGAWA (Toxicology), NORTON (Spiders and Mites, Insect Larval Taxonomy), SIMEONE (Forest and Wood-inhabiting Insects).

Adjunct Faculty

HOWARD (Medical Entomology), JAMNBACK (Diptera Ecology and Control), MORRIS (Medical Entomology), NAPPI (Physiology, Pathology).

Graduate study opportunities are most often found in the basic aspects of insect life and the role of insects in relation to man and his environment. The wide range of effects stemming from insect activity, from the beneficial to the deleterious, allows for a variety of research subjects in which insects play a major role. Thesis topics may concern insects affecting forests, shade trees and wood products, those relating to the health and well-being of man and those playing key roles as biotic parasites and predators of pest species. Current research areas include population dynamics of forest defoliators, pheromone communications among beetles and moths, speciation of insects as understood through behavioral and cytogenetic study, biological control of insects of forest and public health importance and basic biochemistry of insect detoxification mechanisms.

Fish and Wildlife Biology and Management

ALEXANDER (Vertebrates, Herpetology), BEHREND (Vertebrates), BROCKE (Vertebrates), CHAMBERS (Vertebrates), PAYNE (Ornithology), RINGLER (Fisheries Biology), TIERSON (Vertebrates), VANDRUFF (Vertebrates, Ornithology), WERNER (Limnology).

Study in this area provides students with advanced preparation at both the M.S. and Ph.D. levels in biological concepts of fish and wildlife populations particularly as they relate to the proper management of these important resources. Widespread and increasing concern for management of these wild animal resources has been matched by strong student interest in educational programs which prepare them for careers in the fish and wildlife professions. Graduate education, such as is available through this study area, is rapidly becoming a universal prerequisite to employment as a professional fisheries or wildlife biologist.

Areas of research include wetland ecology and management of wetland species, population-habitat relationships, predator ecology, urban wildlife relationships, endangered species studies, feeding ecology of fishes, stream ecology, ecology of larval fishes and homing behavior of fishes.

Forest Pathology and Mycology

GRIFFIN (Fungus Physiology), MANION (Forest Pathology), WANG (Mycology), WILCOX (Mycorrhizae), ZABEL (Forest Pathology and Wood Deterioration).

The study area in Forest Pathology and Mycology seeks to train students interested in developing an expertise responsive to the increasing pressures on forest and shade tree systems for wood fiber, public services, and amenities. This requires new sophisticated levels of disease understanding, disease control, a broad knowledge of fungi, bacteria and viruses, their environmental impacts and their roles in biodeterioration. Areas of staff interest and expertise appropriate for graduate student research emphasis include: environmental, fungal and viral tree diseases; mycorrhizae; wood decay and biodegradation processes; monitoring and impact assessment of disease in forest and urban tree systems; chemical and biological control of tree diseases; epidemiology of tree diseases and the genetics of resistance to tree diseases and to pathogen variability; physiology of fungus growth and development; taxonomy and biology of decay and imperfect fungi; fungus ultrastructure.

Plant Science

GEIS (Ecology), GRIFFIN (Mycology, Fungus Physiology), KETCHLEDGE (Ecology, Bryology), MANION (Pathology), RAYNAL (Ecology, Taxonomy), SCHAEDLE (Physiology), TEPPER (Anatomy, Morphogenesis), VALENTINE (Genetics), WALTON (Physiology), WANG (Mycology), WILCOX (Physiology, Mycorrhizae), ZABEL (Pathology, Wood Deterioration).

Adjunct Faculty

AMES (Physiology), ELIAS (Ecology), FAUST (Taxonomy), KARNOWSKY (Genetics), SETLIFF (Mycology).

Plants, as the principal energy source for ecological food chains, serve as the structual and functional foundation of natural and managed ecosystems. The plant science concentration provides opportunity for study in a broad range of specialties fundamental to the understanding of plants and their interaction with other organisms, emphasizing both forest and related plant systems. Current faculty and student research interests include: dynamics of plant communities as affected by man and the environment; mechanisms of plant succession; epidemiology of forest and urban tree diseases; decay, discoloration and biomodification of wood; taxonomy, physiology, growth and ultrastructure of fungi; heritability of wood properties and disease resistance of trees; biochemistry and physiology of plant growth regulators; photosynthesis; mineral nutrition; mycorrhizae; bryoecology; morphogenesis in shoot and root systems; and plant tissue culture.

Soil Ecology

DINDAL (Invertebrates), HARTENSTEIN (Invertebrates, Physiology), MITCHELL (Invertebrates, Energetics), NORTON (Invertebrates, Taxonomy), GRIFFIN (Fungus Physiology), WANG (Mycology), WILCOX (Mycorrhizae), ZABEL (Wood Biodegradation).

Soil ecology includes the study of interrelationships of soil-inhabiting organisms (as individuals, populations and communities) with their biotic, chemical and physical environments. This field can be considered to be a frontier of science because of the myriad of undescribed species of soil-dwelling arthropods, nematodes and annelids, and the wealth of incompletely understood symbiotic relationships that can be readily discovered by students in this concentration. Soil ecology deals with fundamental aspects of biodegradation and nutrient cycling and is therefore important for improvements in crop culture and enlightened waste disposal.

The soil ecology concentration is supported by courses in physical aspects of soils, plant and animal taxonomy and general ecology.

Zoology

ALEXANDER (Vertebrates, Wetlands), CHAMBERS (Wildlife Ecology, Management), DINDAL (Invertebrates), HARTENSTEIN (Physiology, Invertebrates), MITCHELL (Invertebrates, Bioenergetics), MULLER-SCHWARZE (Vertebrate Behavior), NORTON (Arachnology), RINGLER (Fishery Biology), VANDRUFF (Wildlife Ecology), WERNER (Limnology, Aquatic Ecology).

Adjunct Faculty

BENZO (Physiology), BROWN (Wildlife).

Zoology provides opportunity for in-depth coursework and fundamental research in morphology, physiology, taxonomy and behavior of invertebrate and vertebrate animals. As one of the basic areas in the Department of Environmental and Forest Biology, Zoology is supportive of other concentrations such as Ecology, Fish and Wildlife Biology and Management, and Soil Ecology. Graduate studies in Zoology include both basic and applied research on animals of our natural ecosystem, including their associated soils and waters.

CHEMISTRY

SMITH, *Chairman* (Physical and Polymer Chemistry), CALUWE (Organic Polymer Chemistry), FLASHNER (Biochemistry), LALONDE (Organic and Natural Products Chemistry), LEVIN (Physical and Polymer Chemistry), SARKO (Physical and Polymer Chemistry), SCHUERCH (Wood and Polymer Chemistry), SILVERSTEIN (Ecological Chemistry), SMID (Physical and Polymer Chemistry), SZWARC (Physical and Polymer Chemistry), TANENBAUM (Microbial Chemistry), TIMELL (Wood Chemistry).

Recent years have seen profound advances in the fundamental knowledge of chemical areas which have special significance for forestry and the environment. The following research areas have received active attention by both faculty and graduate students in the programs: polymer chemistry and physics; wood chemistry; environmental chemistry; biochemistry; chemistry of natural products, including ecological chemistry; and materials sciences.

Requirements for a master of science or doctor of philosophy degree in chemistry include a research project and thesis, along with an appropriate program of courses at the College and at Syracuse University.

Specific projects may vary from year to year, since they reflect the current interests of the faculty. Current research projects with *physiochemical* emphasis are: the chemistry, physics, solid-state and solution properties of natural and synthetic polymers, including studies in thermodynamics, statistical mechanics, crystallization, morphology, elasticity, conformation of macromolecules, optical properties, polymer catalysis, mechanism of polymerizations, polyelectrolytes, ion binding to macromolecules and ion pairing; chemistry of free radicals, radical ions and charge transfer processes; structure and properties of ionic solutions in nonaqueous media; crystal structure and morphology of cell wall constituents; heavy metal speciation. Current *organic* chemistry programs deal with synthesis of special polymers such as high temperature aromatic block, stereoregular vinyl polymers, and polysaccharides, various aspects of natural products chemistry, but especially alkaloids and terpenes, isolation and characterization of insect and mammalian attractants. An active program on the structure and topochemistry of the *polymeric* wood components, hemicelluloses, lignins and celluloses is underway. In *biochemistry*, department members are studying mechanisms of action of plant growth hormones, biochemical regulation of seed germination, plant enzymology and ultrastructural plant cytology.

Graduate research laboratories in the Hugh P. Baker Laboratory are well equipped for polymer studies, chemical and biochemical research.

Instrumentation includes analytical and preparative ultracentrifuges, Warburg respirometer, recording infrared and ultraviolet spectrophotometers, mass spectrometer, differential refractometer, electron spin resonance spectrometer, nuclear magnetic resonance spectrometer, automatic membrane osmometers, solid-and solution-state light scattering photometers, recording polarimeter and optical dispersion spectrometer, several ultramicrotomes, electron microscopes, X-ray diffraction, instrumentation chromatography and cold laboratories, and radiochemical laboratories with counters for solids, liquids and gases.

INTERDEPARTMENTAL AREAS OF STUDY

The following two concentrations are offered in collaboration with faculties of the Department of Environmental and Forest Biology and the Department of Chemistry. Interested students should apply to the department of major interest, which will have prime responsibility for setting requirements. Faculty from both departments can aid in the development of a plan of study enabling a student to acquire sophisticated skills in either chemistry or biology and an ample understanding of the other to grapple with problems requiring an understanding of both.

Chemical Ecology

LANIER (Insect Pheromones), LALONDE (Aquatic Plant Secondary Substances), MULLER-SCHWARZE (Vertebrate Pheromones), SILVERSTEIN (Pheromone Chemistry), SIMEONE (Insect Pheromones).

As a relatively new interdisciplinary endeavor, workers in this field attempt to understand organismal interactions, both intra- and interspecific, mediated by chemical substances such as hormones, pheromones, kairomones and phytoalexins. These occur at all taxonomic levels: between uni- and multi-cellular organisms, microbes and plants, plants and plants, plants and animals, microbes and animals, animals and animals. Study of such interactions has been accelerated in recent years through joint efforts of biologists and chemists in meaningful research accompanied by a growing body of literature.

Environmental Biochemistry and Physiology

BREZNER (Insect Physiology), CAMPBELL (Phytoenzymology), FLASHNER (Microbial Enzymology), GRIFFIN (Fungus Physiology), HARTENSTEIN (Invertebrate Physiology), JOHNSON (Environmental Chemistry), NAKATSUGAWA (Insect and Vertebrate Toxicology), SCHAEDLE (Plant Physiology), TANENBAUM (Microbial Biochemistry), WALTON (Plant Physiology), WILCOX (Plant Physiology).

Graduate study may include courses from both departments, and research may include functional and molecular areas. Of current interest are mechanisms of action of plant growth hormones; biochemical regulation of seed germination; plant and microbial enzymology; toxic action and detoxification of insecticides by vertebrate and invertebrate animals; production and action of plant phytoalexins and antibiotics; plant defenses against phytophagous invertebrates; mycorrhizae; ion transport, mineral nutrition, cambial physiology, and photosynthesis.

SCHOOL OF ENVIRONMENTAL AND RESOURCE ENGINEERING

WILFRED A. COTE, *Dean* (Cellular Ultrastructure, Light and Electron Microscopy)

The graduate program in environmental and resource engineering is concerned with optimum development and utilization of the forest and other natural resources. The academic objective is to provide graduates with a sufficient understanding of the methodologies of scientific research and of the principles of engineering. The School program offers unique opportunities for individuals who seek advanced education in such areas as water resource engineering; photogrammetry and remote sensing; and in the materials science and engineering of wood products, paper and related fibrous materials. Science and engineering are the foundation for the individually-designed programs so that applicants with backgrounds in engineering, chemistry, physics, mathematics, forestry or natural sciences can make an easy transition to desired areas of concentration. However, other backgrounds can also be accommodated.

Advanced studies toward an M.S. or Ph.D. degree in environmental and resource engineering may be based on a broad-gauged program emphasizing general aspects of the effective utilization of natural resources or may have a sharply focused research orientation. In either case, the student is able to draw on the combined resources of the three academic departments of the School: Forest Engineering, Paper Science and Engineering, and Wood Products Engineering. In addition, courses and facilities of other schools of the College as well as Syracuse University complement those of the School of Environmental and Resource Engineering when appropriate. Whether a student seeks a broadly based program or wants to stress one area of specialization within the School, there is sufficient flexibility in the program elements to provide for a wide variety of career directions. Examples could include aspects of site evaluation and enhancement, unit and system design, production and processing, qualitative and quantittive measurement and computation. The specializations noted for each member of the graduate faculty within the three departments give further indications of the wide-ranging possibilities offered through graduate study in the School of Environmental and Resource Engineering.

FOREST ENGINEERING

TULLY, *Chairman* (Structures, Water Resources, Soil Mechanics); BROCK (Analytical and Interpretive Photogrammetry, Remote Sensing), LEE (Systems Engineering, Computers, Soil Mechanics), PALMER (Harvesting, Systems Engineering).

Graduate study and research in the forest engineering departments is primarily concerned with engineering analysis and design in concert with other pertinent disciplines for the inventorying and the holistic development of natural resources, with emphasis on those associated with the forest environment. The department's objective is to produce graduates with sufficient understanding of the forest environment and its resources, of the methodologies of scientific research and of the principles of engineering analysis or design to work with competence in resource-related research, engineering design and management.

Individually designed programs leading to the master of science and doctor of philosophy degrees are available. Undergraduate backgrounds required depend upon the student's needs and interests in graduate study. The student may emphasize engineering measurements, analysis or design within the department's breadth of engineering concern for environmental influences and resource utilization. Successful programs of graduate study in forest engineering may be efficiently designed by students with bachelor of science degrees in engineering or in forestry, natural sciences, physics or mathematics.

Programs of emphasis on environmental engineering measurements may be designed in remote sensing, photo interpretation, geodetic engineering, analytical photogrammetry and photogrammetric systems. Programs emphasizing engineering analysis and design are available in water resource, transportation, harvesting and site engineering systems. Included are the monitoring, measurement and evaluation of physical parameters affecting water, soil, timber, vegetation and wildlife.

Support for graduate study and research in the forest engineering department is both internal and external. The internal support includes modern laboratory and instrumentation facilities in the Engineering Schools at both ESF and at Syracuse University. Exceptional departmental support exists for programs in environmental engineering measurements in the form of remote sensing and photogrammetric laboratories and the extensive forest properties owned by the College at which research may be conducted.

External support comes from several active sources, including industrial, commercial and governmental. Over the past two decades, close cooperation has developed special study and research opportunities with these sources.

PAPER SCIENCE AND ENGINEERING

LEOPOLD, *Chairman* (Organic Chemistry and Mechanical Properties of Fibers and Paper), BAMBACHT (Pulping, Papermaking, Water Quality), DENCE (Organic Chemistry and Lignin Reactions), GORBATSEVICH (Pulping, Bleaching, Paper Technology and Paper Properties), JELINEK (Computer Applications, Process Engineering, Corrosion), LUNER (Mechanical and Surface Properties of Fibers, Films and Paper), MARK (Fiber Physics), MARTON (Paper Properties, Microscopy and Pulping), STENUF (Chemical Engineering, Instrumentation, Thermodynamics, Process Control, Metallurgy and Corrosion), TURAI (Water and Air Pollution Engineering, Materials Science and Engineering).

Outstanding for its vigorous growth and diversity of products, the pulp and paper industry is the fifth largest in the nation and exceptionally strong worldwide. The need for professional men and women with advanced education in science, engineering and technology is increasing even more rapidly than the industry itself. The College pioneered graduate study in this area in 1920 with the organization of the paper science and engineering department, which has maintained a singularly high position in professional education for the continuing development of the pulp, paper and allied industries. Its graduates, who are in constant demand, occupy positions of leadership throughout the world.

Graduate studies reflect the strong trend toward diversification in the industry and offer opportunities for obtaining master of science and doctor of philosophy degrees in a variety of subjects related to the manufacture of pulp and paper. Individual study programs are designed to meet specific personal needs. Typical areas of study range from the development of new pulping processes, chemical interactions on the paper machine and the disposal of pulping and papermaking effluents, to the fluid dynamics of fiber suspensions, the colloidal chemistry of papermaking constituents and the physical properties of fiber networks.

Walters Hall, opened in 1969, is devoted exclusively to education and research in the field of pulp and paper. Containing a large number of special purpose laboratories and highly sophisticated equipment, it houses one of the outstanding research facilities in the world, the Empire State Paper Research Institute (ESPRI), an integral part of the department.

The department maintains an experimental pulp and paper mill equipped with machinery and instrumentation for studies of pulping, pulp purification, reuse of secondary fibers, refining, paper additives and papermaking. This facility includes a 42-inch fourdrinier paper machine, a 400-horsepower double-disk refiner, a two-pocket grinder for mechanical pulping and auxiliary equipment. Also included is a modern chemical engineering laboratory, designed for studies in all phases of unit operations and processes, process control and analog simulation.

Research activities aim to generate new information regarding the fundamentals, the science, the engineering and the technology of the papermaking process, utilizing advanced techniques such as electron microscopy, specialized spectrophotometry, nuclear magnetic and electron spin resonance and nuclear tracer methods. Recent work has been directed to fundamental investigations of pulping, bleaching, additives, paper recycling, effluent disposal, the papermaking process, the properties of paper, reactions of wood components during mechanical and chemical treatments, the structure of wood and wood fibers, evaporation, fluid dynamics, heat transfer and chemical recovery.

The department enjoys excellent external support in the form of graduate fellowships and grants from ESPRI and other industry sources, as well as a number of government granting agencies.

WOOD PRODUCTS ENGINEERING

DAVIDSON, *Chairman*, (Physical Properties of Wood); COTE (Cellular Ultrastructure, Light and Electron Microscopy), DE ZEEUW (Wood Anatomy, Structure-Property Relations), KYANKA (Applied Mechanics, Structures), MEYER (Wood-Polymer Systems, Radio-Isotope Techniques), MOORE (Bonded Materials Technology), SIAU (Protective Treatments, Transport Processes), G. SMITH (Materials Marketing), L. SMITH (Polymeric Adhesives and Coatings).

While wood is one of the oldest structural materials known to man, it occupies a position of major economic importance today with the annual tonnage of wood produced in the United States far exceeding that of any other major structural material. This fact becomes even more important in this age of environmental and ecological concern because wood is the only major structural material that comes from a renewable natural resource, and demand is growing for more efficient utilization of available material. Improved efficiency must be based on solid scientific and engineering information. Thus, research projects aimed at providing such information form the basis of graduate study in wood products engineering. The major areas of specialization are *wood science* and *timber engineering.*

Basic degree requirements for either a master of science or a doctor of philosophy degree include appropriate coursework, which prepares the student to undertake a research project culminating in the writing of a thesis.

Recent research projects in wood ultrastructure have dealt with the interaction of coatings and adhesives with the wood substrate, with cell wall development, with the effectiveness of wood preservatives and with the identification of natural inclusions in wood. Projects in tropical wood identification and structure-property relations in foreign timbers are examples of work in the field of systematic wood anatomy. The field of wood physics has had active projects in the permeability of wood, the mechanics of fluid transport and the mechanisms of electric charge transport. Current projects in the field of mechanics are underway in the mechanical behavior of fiber networks, fracture mechanics of wood, the behavior of new structural designs and the mechanical properties of laminated veneer lumber. In addition, there is growing interest in studying the properties of wood-based composite materials, and the chemical modification of wood.

Laboratory facilities include a modern mechanics laboratory which has a wide range of mechanical testing machines, a well-equipped physics laboratory with electronic instrumentation, and complete wood processing facilities including a sawmill and veneer mill, plus dry kilns and preservation equipment. An extensive foreign wood collection provides the basis for the Tropical Timber Information Center (TTIC).

In addition, the College has available a complete microscopy laboratory, containing both scanning and transmission electron microscopes, a wide variety of light microscopes, and related equipment. Extensive equipment for chemical analysis and nuclear chemical techniques also serve the research program.

SCHOOL OF ENVIRONMENTAL AND RESOURCE MANAGEMENT

CHARLES C. LARSON, *Dean* (Resource Policy and Administration, International Forestry)

DEPARTMENT OF MANAGERIAL SCIENCE AND POLICY

DALL, *Chairman* (Environmental Policy and Law), ARMSTRONG (Industrial Economics, Resource and Market Analysis), BENNETT (Economic Theory, Economic Thought in Forestry), CANHAM (Regional Economics and Planning), CHRISTIANSEN (Forest Productions Economics, Economic Systems Analysis), CUNIA (Operations Research, Statistics, Mensuration), GRATZER (Forest Recreation, Resource Management), GRAVES (Resource Policy, Planning, Management), HANSELMAN (Educational Communications), HENNIGAN (Resource Policy, Management), HORN (Law, Business Management), KOTEN (Management, Systems Analysis), MORRISON (Sociology of Outdoor Recreation), PETRICEKS (Macroeconomics, International Forestry Economics), STITELER (Biometry, Experimental Design, Computer Analysis).

DEPARTMENT OF SILVICULTURE AND FOREST INFLUENCES

BERGLUND, *Chairman* (Silvics), BLACK (Watershed Management), CRAUL (Forest Soil Science), ESCHNER (Forest Influences), HERRINGTON (Meteorology), HOWARD (Silvics), LEA (Silviculture), LEAF (Forest Soil Science), NYLAND (Silviculture), RICHARDS (Silviculture, Urban Forestry), WESTFALL (Physiology-genetics, Tree Improvement).

Adjunct Faculty

HEISLER (Meteorology), HORSELY (Silvics), WEEKS (Environmental Education).

The School of Environmental and Resource Management is charged with responsibility for providing quality professional education in natural resource management, with particular emphasis on the resources of forest and associated open lands and their environmental influences, and for the conduct of strong programs of related research and public service. In accord with this broad mission, the School provides formal instruction at both the undergraduate and graduate levels leading to the bachelor of science, master of science and doctor of philosophy degrees.

The undergraduate curriculum in environmental and resource management meets the accreditation requirements of the forestry profession as set forth by the Society of American Foresters. The basic objective of this program is to prepare students for the critical role of evaluating alternate goals in forest and associated land use, of recommending optimum approaches to the realization of these goals, and of working effectively with landowners, resource users and the general public in the formulation and implementation of resource policies and programs in the best interests of all concerned.

Graduate education in the School of Environmental and Resource Management builds upon the basic foundation of professional knowledge acquired by students in its undergraduate curriculum or in similar or closely allied programs of study. Instruction at this level is designed to prepare students for careers in resource administration, professional education and research, and a variety of other specialized positions in public and private employment bearing directly or indirectly on natural resources and environmental management.

The School offers advanced study opportunities under two broad degree programs: Resource Management and Policy, and Silviculture and Forest Influences. In addition, its faculty contribute significantly to several College-wide graduate programs and joint areas of advanced study, including fish and wildlife, managerial science, water resources, environmental planning, environmental science, and soils science.

Several areas of specialization are available within the two degree programs. Opportunity is also provided for students, in consultation with faculty advisors, to arrange areas of study specific to their interests and needs which integrate elements of two or more areas of specialization, as in the case of world forestry. Whatever the program, the basic purpose is to help the student acquire the tools and facility for disciplined, logical, critical, constructive and creative thinking, and for clear expression in the selected field.

Prospective students who desire more information than is presented for each of the graduate programs and specialties described below should contact the Dean, School of Environmental and Resource Management.

RESOURCE MANAGEMENT AND POLICY

Today's successful resource manager is one who can anticipate and prevent environmental troubles as well as attempt to remedy them; who is equipped not only to make current institutions function effectively, but also to create new ones better fitted to changing social needs; and who can bring the strengths of many disciplines to bear on vexing environmental problems.

The graduate program in Resource Management and Policy is designed to meet the needs of students for broad theoretical education and training in techniques for application in a variety of resource conservation fields. The program is administered by the Department of Managerial Science and Policy of the School of Environmental and Resource Management. The department offers instruction in social sciences, law, management, administration and quantitative methods for its own as well as in service to other programs of the College.

Students have options to emphasize studies in applied fields but each individual must make selections, with faculty approval, to comprise a meaningful, coherent, interdisciplinary study plan. Applied fields are described below and include forest management, forestry economics, policy and administration, environmental communications, land use planning, quantitative methods, and recreation management. Typically, the study plan is designed by an individual in consultation with a major professor and other members of the faculty as the case may require. The criteria used include the student's undergraduate preparation, his study and career objectives, and our institutional capabilities. Courses are selected from the departmental offerings, the offerings of other departments of the College (described in this catalog) and those of Syracuse University.

Master's Degree Program

The entering student is expected to have a body of knowledge obtained through undergraduate study which includes biological, physical and social sciences. Graduates from such programs as forestry, agriculture, wildlife management, watershed management, or liberal arts with a sufficient background in the sciences should qualify. In a number of cases, students will have to make up for the lack of required knowledge by taking undergraduate courses.

During the first year, all students in the program are required to take four core courses, in order to obtain a minimal base for becoming qualified for professional service in resource management and policy. These four courses are:

RMP 601 - Resource Management Systems
RMP 602 - Resource Economics
RMP 603 - Research Methods in Resource Management and Policy
RMP 753 - Resources Policy

The remaining coursework will be built around such subdivisions of the program as forest management, quantitative methods, land use planning, recreation management, policy and administration, and forestry (resource) economics.

A thesis is also required. The approach to thesis writing may be based on collection and interpretation of primary data, or emphasis may be placed on reading and secondary data, thus acquiring additional knowledge in an area of resource management and policy chosen by the student.

The total credit requirement is 30 semester hours, including the thesis. The normal time for completing these requirements is three semesters.

Ph.D. Degree Program

Requirements for the doctorate usually build upon a master's degree, and demand a substantial mastery of material related to the dissertation topic. At the same time, a number of other fields are chosen to support or integrate the selected central topic of doctoral study. There is no minimum credit requirement, but the normal course workload is 30 credits. The field work for and the writing of a dissertation usually requires a minimum of 12 months.

The additional requirements for a doctoral program, beyond a master's degree, are a residence of two continuous semesters; passing of written and oral comprehensive examinations which are intended to test the student's integration of subject matter; and the writing and successful defense of a dissertation.

The topics for a doctoral dissertation would typically fall within one of the areas mentioned for master's study, namely forest management, quantitative methods, land use planning, recreation management, policy and administration, and economics. A brief description of these areas follows.

FOREST MANAGEMENT

The forest management area focuses on the planning and implementation processes necessary to achieve integrated use of forests and related resources. The objective is to develop expertise sufficient for capable, professional resource management to satisfy a wide range of societal needs.

Broad knowledge of the operation of both biological and social systems is combined with skill in the use of managerial tools. Concepts in decision theory, and information and organization theory, particularly, are applied to representative cases at varying levels of complexity. Syracuse University's School of Management and Maxwell Graduate School of Citizenship and Public Affairs offer a broad array of support courses. Students prepare themselves for any of a wide range of positions in research, program analysis, teaching, administration, budgeting and other phases of forest resource management with federal and state agencies and private firms.

RECREATION MANAGEMENT

Graduate study in this area equips students with a broad understanding of the nature and purposes of outdoor recreation and how they relate to natural resources, and builds the skills necessary for capable recreation management.

Individual programs combine study in resources management with relevant studies in the social sciences and development of analytical and political capabilities needed to implement plans and programs. Other schools of the College and of Syracuse University, treating such areas as planning, engineering, design and education, provide a wide range of supporting courses and facilities.

POLICY AND ADMINISTRATION

Graduate study in the area of policy and administration prepares students for the broad range of responsibilities comprising the field of program administration in a public agency or a business at the executive, planning, budgeting, programming or operating levels. Advanced courses, special problems and seminars structured around human relationships to resources, resources policy issues, administrative management, and environmental law are offered.

Students are encouraged to round out their academic programs through the offerings of other units of the College as well as the Syracuse University Maxwell Graduate School of Citizenship and Public Affairs and the School of Management.

The wide-ranging possibilities of course selection and the differing points of view that are available allow the student to tailor a program to meet specific career objectives. This breadth and diversity also offers the student an opportunity to develop talents for top executive leadership in various aspects of a field that is critical to the future of resource management.

FORESTRY ECONOMICS

In this area, study at the master's level is designed to meet the needs of the graduate in forestry or forest products. It also serves the graduate in liberal arts, engineering or business whose interests point toward the economics of forest resource management. The aim is primarily to broaden the student's understanding of the content of forestry economics.

The Ph.D. program is for those who wish to make a career as professional forestry economists in research institutions, in the academic world, or in business or government. The goals are depth of understanding and familiarity with economic tools contributory to making competent decisions in resource economics, management and policy. Requirements are generally the same as those observed in economics departments of leading universities, except that the student completes specified work in the economics of forestry.

Individual programs may include supporting courses in general economics, mathematics and statistics, operations research, business, international affairs and other social sciences and related fields. The broad array of course offerings and substantial library resources, computer facilities and other resources of Syracuse University supplement those of the College.

QUANTITATIVE METHODS

Study in the area of quantitative methods is designed to develop professionals skilled in mathematical and statistical problem solution and equipped to act as biometricians, mensurationists or in similar posts with state and federal agencies and with private firms.

The program is designed primarily for students who have done their undergraduate work in areas such as biological sciences, forestry, wildlife or agriculture. Others, who lack background courses, may take this material concurrently. Students may concentrate in statistics, operations research, biometry, or forest mensuration. Syracuse University's IBM 370 computer, programming banks and a wide range of courses in mathematics, statistics and quantitative methods give strong support to the program.

LAND USE PLANNING

Graduate study in land use planning aims to show how development and utilization of land affects and is affected by natural and social systems. It provides basic understanding of the tools and processes of regional planning and addresses land use policy issues. Student programs are flexible and draw heavily from course offerings in resource economics, resource policy and administration, open space planning, and applied ecology. In addition, the rich course offerings of other Schools and Syracuse University in such areas as remote sensing, geography and metropolitan studies are available. Some undergraduate work in the natural and social sciences is required.

Employers normally include county, regional and state planning commissions; federal agencies such as the Forest Service; and private consulting firms. Consultation from these sources is encouraged in graduate theses and research, and in the conduct of seminars.

Graduates find employment in resource management agencies administering recreation areas; in national, state and local parks and recreation departments; in educational institutions; and in private organizations involved in recreation.

ENVIRONMENTAL COMMUNICATIONS

This area of study prepares specialists to effectively interpret for a wide range of publics the biological, ecological and socioeconomic events that relate to natural resource management and use, and the protection and enhancement of environmental quality. Understanding of the operation of natural resource systems and of social and managerial systems is combined with expertise in education and in the tools of communication (including print, nonprint and other instructional technologies) to develop skill in analyzing and interpreting resource and environmental affairs.

Individual study programs draw heavily upon instructional resources not only within the School of Environmental and Resource Management, but also in other schools of the College and Syracuse University, especially the latter's Newhouse School of Public Communications. Independent studies, special projects and internships are often a major component of study programs.

The breadth of study options allows students to orient their career goals within a wide range of employment possibilities. Graduates find employment with resource management agencies, industrial firms and associations, community environmental education centers, private environmental organizations, conservation associations, professional societies, post-secondary educational institutions, and the mass media.

Those who aspire to study in this program area must possess or be prepared to acquire the necessary background for graduate candidacy in resource management and policy. Students who do not have such background or whose career objectives are not commensurate with resource management will be encouraged to pursue their environmental communication interests through the Graduate Program in Environmental Science described elsewhere in this catalog.

SILVICULTURE AND FOREST INFLUENCES

Concern for the forest ecosystem provides a major focus for graduate study in the Silviculture and Forest Influences Program. This ecosystem is viewed as a producer of goods and services as a modifier of the physical environment in which man lives. It is in this context that translation of these concerns to broader questions of environmental quality is emphasized.

Silviculture in its functional sense is the bridge between fundamental biological and physical relationships and the applications of these relationships in the forest environment. Thus, graduate study in the many aspects of silviculture can cover a broad spectrum of disciplines, and can be as basic or as applied as the objectives of the student indicate. Individual study programs are coordinated with various areas of specialization both within the Department of Silviculture and Forest Influences and with other departments of the College, of the State University of New York, and with Syracuse University. A major strength is the close association of faculty scientists, representing a wide range of specialties, and the formal and informal cooperative arrangements they have developed with their counterparts in federal and state agencies, and in industry.

Physical facilities that are routinely used in graduate study within the Silviculture Program include well-equipped laboratories, specialized equipment, greenhouse facilities, and extensive College forests.On these 25,000 acres of forestlands are located natural and planted stands, seed orchards, a forest tree nursery, and two large micro-climate tower complexes with associated automated data acquisition systems and instrumentation. Major field installations include long-term northern hardwood stand improvement studies and the oldest continuous forest fertilization study in the United States. Cooperative arrangements also exist for work on corporate lands, private properties and governmental ownerships.

Qualifications for Admission

In addition to the general College-wide requirements for admission to graduate study, applicants to the graduate program in Silviculture and Forest Influences should have prior education or experience in resource management and have a deep personal commitment to forest resource management as a career goal. Students with preparatory deficiencies may be permitted to take corrective coursework.

Minimum Requirements

MASTER OF SCIENCE

Candidates for the master of science degree are required to complete two semesters in residence and 30 semester hours of graduate work beyond the baccalaureate degree. From 6 to 12 semester hours of this total can be credited for writing and defending a thesis.

DOCTOR OF PHILOSOPHY

The Ph.D. program usually builds upon a master's degree and demands substantial mastery of material related to the dissertation topic. At the same time, a number of other fields are chosen to support or integrate the selected central topic of doctoral study. There is no minimum credit requirement but the normal course workload is 30 graduate credits beyond the master's degree. In addition, the fieldwork for and the writing of the dissertation usually requires a minimum of 12 months.

Candidates for the Ph.D. degree must be in residence for two continuous semesters, pass a written and oral comprehensive examination, and write and defend a dissertation.

At both the M.S. and Ph.D. levels, students may or may not be required to demonstrate competency in one or more foreign languages or research tools, depending upon their area of orientation and career goals.

Fields of Specialization

Included within the Silviculture and Forest Influences Program are five fields of specialization that, singly or in combination, provide the graduate student with a wide array of coursework, research activities and faculty guidance all aimed at enhancing his understanding of the forest ecosystem. These specializations are silvics, silviculture, forest soil science, tree improvement and forest influences. Students in the program can direct their studies toward careers in professional practice, research, or education. Similarly, study in these specialty areas can emphasize any of a number of areas of professional application, such as public or private forest management, urban forestry or world forestry, depending on the individual's interest.

SILVICS

Silvics has been defined as that branch of forestry which provides the scientific base for the cultural treatment of forest vegetation by (1) studying and defining interrelationships within forest ecosystems and (2) cataloging general intraspecific characteristics of tree species. In a sense, silvics is the ecology of managed forest ecosystems, although unmanaged and natural forests are often studied intensively to provide the benchmark conditions from which the silviculturist begins.

The specialist in silvics must maintain channels of communication with colleagues in the basic disciplines, including those in soil physics, soil chemistry, micro-meteorology and climatology, genetics and tree breedings, plant ecology and physiology, wildlife biology, entomology, and pathology. In addition, certain tools, including a comprehensive knowledge of probability and statistics, the ability to use modern computers effectively, and a familiarity with measurement and sampling theory, are required by specialists in most applied sciences including silvics.

The specialist in silvics is essentially at one focal point of much of what has been called fundamental forest research. His most useful function and worthwhile contribution to the field of forestry may very well depend on the ability to synthesize relevant material and, through experimentation, provide the silviculturist with information and possible techniques for use in the cultural treatment of forest vegetation.

SILVICULTURE

Classical silviculture can be defined as the theory and practice of the manipulation of forest ecosystems, including the control of vegetation establishment, composition, growth, and quality. The nature of cultural treatments, the theories upon which they are based, and the biological, physical, and social constraints to their implementation are stressed in this area of specialization. Elements of forest vegetation are intensively examined from the dual standpoints of fulfilling management goals for goods and services and maintaining or enhancing biotic productivity for the future.

Management goals are considered to include all the many and varied goods and services that the basic forest resource is capable of supplying. Forest productivity is of basic concern; the student specializing in this area progresses through formal coursework and research toward an understanding of the effect of various treatments on the continuous, balanced, and adequate supplies of wood, water, wildlife, recreation opportunities, and amenity values. One major area of emphasis within this specialization relates to treatment of tree stands for their continued production of wood products and other commodities. Another emphasis centers on the treatment of stands that are managed for several values simultaneously, where the harmonious integration of uses is of concern. A third emphasis focuses on evalution and manipulation of vegetation systems primarily for their on-site values, such as in wilderness and recreation areas, highway and utility rights-of-way mining and other wasteland reclamation, and urban greenspace. This involves a broad interpretation of forest ecosystems that includes herbaceous and shrub systems as well as silvics.

The Silviculture graduate specialization is aimed at preparing foresters to understand and evaluate forest ecosystems in whatever depth may be required, and to prescribe treatments or further experimentation to attain management objectives or increase knowledge toward this end.

FOREST SOIL SCIENCE

Graduate studies in this area of specialization may be directed toward aspects of soil science related to the quantity and/or quality of goods and services in the management of resources of nonagricultural lands, and the impact of managment practices on environmental quality. These include soil moisture, soil temperature, and nutrient element status interrelationships in the evaluation of soil productivity; evaluation of ecosystems to quantify nutrient element balances and cycling; amelioration of soils for increased productivity; and impact of various land-use practices on soil productivity.

Modern well-equipped laboratories are available for graduate student use in plant, soil, and water chemical analyses; soil water-holding capacity and compaction; infiltration and runoff; and other chemical and physical property investigations. The extensive College properties noted previously permit forest soil research to be conducted under a wide variety of environments and ecological conditions.

Programs are coordinated with other areas of specialization through cooperation among Department personnel, with other departments of the College, Syracuse University, and the U.S. Forest Service.

TREE IMPROVEMENT

Tree improvement has become an important component of intensive forestry practice. Its main objective is to breed for commercial distribution varieties of trees that are well adapted to such specified conditions as management objectives, cultural practices, and physical and biological site factors. As a specialized study area, it draws upon such fields as genetics, plant biochemistry and physiology, and statistics.

FOREST INFLUENCES

Forest influences as an area of graduate study includes all the effects resulting from the presence of forest trees and associated vegetation on climate, the hydrologic cycle, erosion, floods, and soil productivity. Health considerations and human comfort have often been included in older definitions of forest influences, and are assuming greater importance today with our growing concern for the environment.

Included among the principal studies in this area are energy exchange between forest and atmosphers; moderation of urban environments by vegetation; soil and slope stability; and watershed hydrology, including snow.

Graduates fill a variety of positions in research, teaching, and public and private management as watershed management specialists, hydrologists, environmental officers, meteorologists and ecologists.

WORLD FORESTRY CONCENTRATION

Graduate education in world forestry as an area of emphasis is available to students under both the Resource Management and Policy, and Silviculture and Forest Influences programs and is designed to assist individuals who are intent upon pursuing internationally-oriented careers in forestry and related fields.

Instruction is aimed at supplementing and enriching the student's technical forestry knowledge and providing the broad background deemed necessary for effective service in a variety of professional areas. These include forestry advisor, teacher, or research specialist with national and international agencies, private business and industrial firms, philanthropic foundations, and voluntary service organizations whose activities include the development and use of forest resources in other lands.

At the master's level, program emphasis is on the attainment of general competence in research methods, foreign languages, cultural anthropology, world geography, and international affairs, plus a broad understanding of the world forestry situation. At the doctoral level, program concentration is on a specialized discipline area such as forestry economics, forest policy and administration, forest management or silviculture. Orientation to the world forestry field is achieved in part through the selection of formal coursework, and in part through providing an opportunity for the student to conduct his thesis research in residence abroad.

A wide variety of course offerings are available to support the non-forestry elements of this area of study through Syracuse University. Opportunity for field training and research in tropical forestry and related fields is available to qualified candidates, especially at the doctoral level, under cooperative agreements maintained by the College with the Institute of Tropical Forestry in Puerto Rico and the University of the Andes, Merida, Venezuela.

URBAN FORESTRY CONCENTRATION

Graduate study in urban forestry allows the student to pursue either of two broad objectives. Professional urban forestry skills may be broadened in the many areas of information important to the practice of forestry in urban and urbanizing areas through advanced coursework and applied research. More specialized study may be pursued in scientific disciplines supporting the practice of urban forestry. Active areas of specialized research and study in the School includes soils, greenspace ecology, atmospheric science, tree improvement, forest resource inventory and evaluation, and resource economics and planning. There is strong interaction with other urban-related areas of study within the College, including remote sensing, botany, pathology, entomology, and wildlife ecology. Both the Department of Geography and Maxwell School of Citizenship and Public Affairs of Syracuse University and the Pinchot Institute of Environmental Forestry Research of the U.S. Forest Service, Northeastern Forest Experiment Station, cooperate with many of the ongoing research and study programs of the School of Environmental and Resource Management.

COLLEGE-WIDE PROGRAM IN ENVIRONMENTAL SCIENCE

A Perspective

Environmental science is the study of people and their relationships with the environment. The environment is the physical, chemical, biological, and social setting in which people live, work and play. Consequently, environmental science is concerned with the natural setting, the culture imposed by man in this setting and the institutional system man has devised to order the relationships between many conflicting demands and desires in light of natural and social constraints. Few, if any, locations on this earth are totally independent; external dependencies and impacts exist, to a greater or lesser degree, and must be factored into this environmental matrix.

Environmental science connotes a holistic orientation, one that recognizes interdependence and interrelatedness of all the social and technical facets of the environment, as opposed to an atomistic orientation whmch treats these facets as fragmented and unrelated. Armed with this perspective it is apparent that the environmental problems facing society today are a product of human interaction with the environment, not simply a number of technological difficulties.

Present day interest and concern with environmental matters had as its antecedents the separate development of conservation and public health programs in the 1880s which had a rather narrow focus. These concerns became progressively broader under the press of social and technological growth in the 40s, 50s, and 60s. A new environmental movement then emerged outside of these traditional approaches culminating in Earth Day, 1970.

This environmental movement enlisted a constituency outside of the conservation and public health traditions and agencies. Conservation and public health elements were combined in a unified approach. The resource focus of conservation and the people focus of public health became merged into the single focus of people and resources. The goal is to maintain acceptable environmental conditions, while simultaneously providing for the effective utilization of resources.

In order to meet the demands for a broader integrative approach to environmental affairs, a number of new statutes were passed, epitomized by the National Environmental Policy Act; new agencies were formed, old agencies were reorganized. The new participants included citizen activists, lawyers, natural scientists, and planners in unprecedented numbers to add to the cadre of professionals and citizen activists from the public health and conservation traditions. One major result of this was the realization that the environment must be viewed holistically, and that there were two major aspects to all environmental issues, the technical-scientific, and the political-social. This requires that all students of environmental science fully understand and comprehend both of these components of environmental affairs.

THE PROGRAM

The Graduate Program in Environmental Science resulted from the realization that there is a need to provide an opportunity for interdepartmental and interdisciplinary study. Consequently, the faculty for the program is drawn from the faculty of the existing schools and departments.

Other important inputs to this program are the resources of Syracuse University in the coursework areas of communications, policy, law, engineering, science, sociology and political science, and the community and institutional resources of the region such as federal, state, and local agencies, faculties of other colleges and private organizations.

PROGRAM OBJECTIVES

The GPES is designed to prepare graduate students for careers in environmental affairs. This includes working in such diverse areas as teaching and research, communications, planning, regulatory administration, general administration, policy and program analysis. The emphasis can be technical-scientific or institutional-social with varying blends of the two.

Students enter directly from undergraduate schools or, as is increasingly happening, after some years of professional experience. The goals of the entering students vary considerably such as development of needed career skills and expertise, career changes, adding breadth to a technical background, adding depth to a general background, and mid-career updating.

AREAS OF STUDY

The areas of concentration now being offered under the GPES are environmental education/communication, environmental assessment and impact analysis, environmental land use planning, and water resources. These areas are not exclusionary. It may well be that a student will desire a program that does not fall into the listed categories. This need can be met providing that the faculty resources are available in the College and associated institutions. Students with a desire for a highly individualized program falling within the scope of the College's offerings are encouraged to make application for admission.

Students with an undergraduate major in engineering, science, mathematics, political science, economics, journalism, public communications or forestry would be best prepared to undertake a graduate program in environmental science. All applicants must meet the general admission requirements of ESF. Each applicant is evaluated on an individual basis and judgment is exercised if the student appears to be deficient in some aspects. Considerations include years of experience, maturity and motivation. Potential applicants should not hesitate to submit applications for consideration. All applicants are urged to visit the campus and confer with appropriate faculty and administrative personnel.

REQUIREMENTS

Program requirements are designed on a highly individual basis. The purpose is to design a program that fits the students' particular needs, goals and preparation. Each program must meet the need for *depth* in a particular area, *breadth* across the environmental spectrum and *synthesis* of information and analysis in evaluating environmental situations. Program evaluation is based on undergraduate work and experience, as well as courses taken at the College. The program must also be coherent, logical, and result in a meaningful whole. Current areas of study are:

Environmental Education/Communication

The Environmental Education/Communication area of study is concerned with those facets of environmental protection, enhancement, management and design in which the flow of information and the processes of education are integral to end results. The basic emphasis is to integrate a solid and substantial background in environmental science with a mastery of appropriate education and communications theory and practice in such a manner as to prepare students in the program for careers in environmental education and communications.

Although closely related, there are several rather distinct career areas under the umbrella of EE/C for which this program unit provides preparatory graduate degree training. These career areas can be generally categorized as follows: Public Information Officer, Environmental Education Specialist, Extension Specialist, Interpretive Naturalist, Environmental Journalist.

Water Resources

The Water Resources area of study is based on the recognition that water relationships are important in almost every aspect of human concern and merit attention as integrative and central elements rather than accessories.

The thrust of the program is either technical or social depending on student interest. The technical is concerned with water quality and quantity relationships, their quantifications and determinants. The social aspect is concerned with planning, regulation, law and institutions, and management. National concern with water resources planning, water supply and water pollution control attest to the need for people trained in these areas.

Environmental Assessment and Impact Analysis

The main objective of this area of study is to bring together, in an organized educational unit, the various skills and disciplines required for an environmental impact analysis. In practice, such an analysis is a team effort, and the program is intended to ensure that potential team members are conversant with, and operationally adapted to, the language and procedures of a number of the disciplines involved. Starting with students who have an in-depth background in a traditional (i.e., chemistry, biology, engineering, ecology, forestry, et al.) discipline, the program seeks to refine existing strengths while at the same time broadening the students' ability to deal effectively with the complex, interdisciplinary problems which arise in studies of environmental impact. To ensure the depth and breadth aspects simultaneously, the academic plan stresses a problem-oriented team research approach.

Environmental Land Use Planning

The land use planning area of study is based on the concept that land use is a fundamental determinant of environmental conditions be it water pollution, air pollution, population density, solid waste disposal, or other impacts. The program is designed to acquaint the student with the physical elements of land use such as location and natural resources, and the social side relating to law, economics and regulation. Land use management and control is fast becoming the major environmental issue of the day. Land use planners and implementors are sorely needed on a local and regional level. This program unit proposes to meet that need.

Environmental Science

This is not a specific area of study but a program element to provide for the highly individual program designed to meet a particular student's needs. The emphasis can be on any appropriate subject within the resources of the College and related institutions.

THE STUDENT

A major advisor is assigned by the program director to accept primary responsibility for the program of each student. Two additional faculty members in areas of expected academic or research emphasis are also selected. These three faculty members constitute the academic program committee for the student. The student is required to submit a formal proposal to the committee consisting of a detailed plan describing and defending the academics and research objectives of the program and a schedule of courses to be taken. The plan is reviewed and updated at the beginning of each semester. The program committee also serves as the thesis or project committee.

The program operates within the College-wide requirements for graduate students. All students in the program are required to participate in the environmental science seminar which brings together a variety of lecturers with a wide spectrum of interest. Communication, and a campus visit and an interview are highly recommended prior to or during the application process.

SCHOOL OF LANDSCAPE ARCHITECTURE

ROBERT G. REIMANN, Dean (Methods and Philosophy of Design)

CURRY (Urban Analysis, Design), EARLE (Cultural and Art History, Art, History of Environmental Development and Attitudes), FELLEMAN (Site Systems Engineering, Route Location, Public Works Administration and Resource Data Banks), FREEMAN (Site Design, Plant Materials and Graphics), HARPER (Regional Environmental Planning, Visual Quality Assessment, Archaeological Environmental Analysis), HIBBARD (Environmental Design), LEWIS (City and Regional Planning, Gaming and Simulation, System Dynamics), MARAVIGLIA (Technical Graphics and Communications), PAULO (Law, Basic Design, Site Analysis and Design), POLLAK (Urban Planning, Human Behavior and the Designed Environment), SALON (Basic Design, Site Design), WARBACH (Basic Design and Graphics).

LANDSCAPE ARCHITECTURE

There has always been a need and a desire for humans to adjust to their physical environment, or to modify it in order to meet requirements of shelter, sustenance and communication. Society has reached the point in the latter half of the 20th century where economic and technological sophistication enables it to completely control the physical environment. It is within the balance between humans and nature, and the manipulation of land as it relates to human use, that the role of the landscape architect lies. The landscape architect is concerned with the visual quality and form of the physical environment. The professional is concerned with the interrelationship of people and land. The dynamics of this relationship have led to a professional commitment to meet changing societal needs. Because of this concern, the landscape architect may work at any scale, from the design of small site projects with their related designed amenities to the orchestration of regional, national, or international projects which attempt to develop policy for qualitative use of land.

The graduate program at the School of Landscape Architecture was conceived as a means to meet the needs of society and the expanded scope of landscape architectual services. The program is based upon a conceptual premise that sees the central skills of the landscape architect as an understanding of design theory and process as these relate to a range of services beyond the level of project design. Building upon this premise, the program maintains as its central core an emphasis on design theory and process while requiring students to pursue concentrated study of the interrelation between design and an area of concentration.

Relation Between the B.L.A. and M.L.A. Programs

Two professional degree programs are offered at the School of Landscape Architecture. The bachelor of landscape architecture degree is a program emphasizing skills in project design. The program is offered to students who hold a bachelor degree from other institutions or who begin following two years of study at another college or university. In both cases, the B.L.A. program is of three-year duration and is intended to prepare students to provide that scope of services associated with project or site design. Students obtaining the B.L.A. usually have career goals which include obtaining a license to practice landscape architecture. For further information, consult the College's Undergraduate Catalog.

The master's in landscape architecture is offered to those students who hold an undergraduate degree and meet the prerequisites for admission. The two-year course of study at the master's level builds upon a student's understanding of design theory and process while emphasizing mastery of the skills associated with these. Students are required to integrate design with an elected area of concentration in the social or natural sciences or specialize in further understanding of design process and methods. The program requires cross-disciplinary study to prepare students to enter a variety of positions not traditionally held by landscape architects. Illustration of these positions may be found in design research, energy conservation, design review and management. Although these positions require an understanding of design, they do not demand the traditional skills normally associated with project design. However, skills in management, analysis techniques, technological application, and the social and natural sciences are considered necessary to undertake these and other similar positions. Graduates of the program are currently employed by government, educational institutions and private offices practicing landscape architecture across a broad and comprehensive scope or purview.

M.L.A. PROGRAM

The M.L.A. curriculum has three components: a sequence of required, core courses; a series of elected courses in an area of concentration; and a thesis or project. The required core courses have as their focus the development, enhancement and refinement of understanding of landscape architectural philosophy, theory, skills, and techniques. Emphasis is placed on the refinement of proficiency in design research skills, concepts, and objectives.

Each student is required to select and complete a group of courses in an area of concentration in one of three design-related areas. These areas are in social/behavior studies, natural/physical applied sciences, or design process, methods and management. Selection of an area of concentration is the responsibility of each student assisted by a faculty advisor.

Every student is required to prepare a thesis or project which is reviewed by a committee of faculty. A thesis consists of research which expands or clarifies either basic knowledge of landscape architecture or knowledge related in some way to the expanding scope of landscape architecture. A project consists of the application of professional knowledge and skills to a landscape architectural problem in order to develop a solution.

In general, the following describes the broad sequential purposes of the four-semester program:

First Year, Fall Semester: The first semester of study is intended to review landscape architectural design theory and process as well as introduce students to emerging areas of professional work. An examination of the impact of socio-cultural factors on the environment is provided.

First Year, Spring Semester: The second semester of study is intended to investigate design through a variety of projects focusing on the form and condition of environments supporting human behavior. Methods of research and analysis relevant to the behavioral sciences are introduced.

Second Year, Fall Semester: The third semester of study is intended to investigate the potential interrelationship between natural systems and design. Through a large-scale planning project, students investigate the tolerances of natural systems and their responsiveness to alteration.

Second Year, Spring Semester: The final semester of study consists of intensive work on a thesis or project, as well as continued study in the selected area of concentration. It is anticipated that the thesis/project consists of a study examining an aspect of the area of concentration and its relationship to landscape architecture.

Research plays a significant role in the graduate program, primarily through funded projects and thesis/projects. Not only does research provide new knowledge and applications for the profession, but it enriches the curriculum, enhances faculty expertise and develops student skills in rigorous observation, clear thinking and lucid writing.

By the nature of a profession which exists on shifting frontiers of human interaction with natural and built environments, much of the research in landscape architecture deals with new and intangible issues in an exploratory way. Faculty members and graduate students usually work together on research projects in an atmosphere of mutual learning. Approaches may vary from rigorously quantitative analysis of data to highly qualitative evaluation of broad problems to application of design and planning methods to specific cases.

The College library and the several libraries on the Syracuse University campus offer reference material to support study programs. Facilities at the School are extensive. They include adequate studio and office space as well as reproduction, model making, photographic and audio-visual equipment. The College maintains a computer center which is used primarily for instruction and is available for individual use by graduate students. The College also has a fully-equipped video tape recording (VTR) studio and photogrammetric labs.

The School is unique in its location within the College of Environmental Science and Forestry. This situation provides the M.L.A. candidate with the opportunity to draw upon information and knowledge in ecology, natural sciences, resource management, forestry and many other related environmental disciplines. In addition, the relationship with Syracuse University provides the School with an extensive intellectual as well as physical resource basis.

The Syracuse area has the largest concentration of landscape architectural firms in the state, outside of New York City. With a metropolitan population of nearly 500,000, the city has many opportunities for urban-oriented study. Also, the city's central location in Upstate New York provides easy access to a rich variety of public lands and recreation areas which are planned and administered by a diverse range of governmental agencies and private owners.

Students seeking admission to the M.L.A. program must meet the following prerequisites:

1. Coursework. The following areas of study must be completed prior to admission. A student may elect to take these courses at the School of Landscape Architecture or at another school. If a course is taken at another school, however, it is important that a student ascertain that the content described below is provided. The prerequisites will be met on this campus by taking the junior year of the undergraduate program. A student desiring to do so should contact the School of Landscape Architecture.

   Design: two applied studio courses which examine landscape architectural design theory and process through application to specific projects.
   Landform: one course which examines the types of landforms that exist in nature and which surveys the adaptation and manipulation of these for new uses.
   Basic Ecology: one course which examines the basic scientific principles of natural systems.
   Basic Computers: one course which introduces students to use of computers.
   Social Sciences: one course which introduces students to the scientific study of an aspect of human behavior (e.g., sociology, anthropology, psychology).
   Natural Sciences: one course which introduces students to the scientific study of an aspect of the natural sciences (e.g., biology, botany, geology, dendrology).
2. An undergraduate degree.
3. Graduate Record Examination scores.
4. Undergraduate transcript.
5. Three letters of recommendation.
6. Design portfolio.
7. A written statement of the purpose and goals of seeking a master of landscape architecture.
8. TOEFL scores for those applicants whose native language is not English.

Applications should be made to the College prior to March 1; letters of acceptance from the School are mailed out to the applicant prior to mid-April.

Graduate Exchange Programs

INTERCAMPUS DOCTORAL EXCHANGE

There is an opportunity for doctoral students at ESF to study for one or two semesters at the following schools: State University Centers at Albany, Binghamton, Buffalo, or Stony Brook; City University of New York; or New York University.

This exchange program provides students with an opportunity to take advantage of over 160 faculty, specialized research laboratories and equipment, technical libraries, and field study areas which complement the extensive programs and resources at ESF which are discussed throughout this catalog.

This fellowship provides a grant-in-aid of up to $5,000 a year plus a tuition waiver. For further information, please contact the Office of Academic Programs.

COLLEGE OF AGRICULTURE AND LIFE SCIENCES AT CORNELL UNIVERSITY

The State University of New York College of Environmental Science and Forestry and the New York State College of Agriculture and Life Sciences at Cornell University provide an opportunity to exchange graduate students so they can take advantage of special courses, faculty and research facilities.

There are a number of programs on both campuses which complement one another. The following research and instructional areas at the College of Agriculture and Life Sciences appear likely to be of greatest interest to ESF students.

Agricultural Economics—Land Economics; Resource Economics; Resource Investment and Environmental Quality; Agricultural Land Policy.

Agricultural Engineering—Physical Analysis of Plant and Animal Materials; Soil and Water Engineering; Environmental Systems Analysis; Drainage Engineering; Soil and Water Conservation.

Agronomy—Identification, Appraisal and Geography of Soils; Soil Fertility Management; Soil and Water Conservation; Aquatic Plant Management; Forest Soils; Soil Microbiology; Microbial Ecology; Use of Soil Information and Maps as Resource Inventories; Soil Organic Matter; Soil Chemistry; Weed Science; Dynamic Climatology; Physics of Clouds, Rain, and Rainmaking.

Natural Resources—Wildlife and Fisheries Management; Environmental Conservation; Resource Analysis and Planning; Woodland Management; Forest Ecology; Maple Syrup Production.

Floriculture—Woody Plant Materials; Herbaceous Plant Materials; Plants and Design.

Entomology—Insect Pest Management; Arthropod Pests of World Importance; Biological Control; Insect Pathology; Environmental Biology; Pesticides in the Environment.

Plant Breeding and Pathology—Plant Cell Genetics; Methods of Plant Breeding; Genetics and Breeding for Disease and Insect Resistance; Plant Pathology; Advanced Disease Control; Dendropathology; Pest Management for Plant Protection; Advanced Mycology; Plant Virology; Plant Nematology; Bacterial Plant Pathogens; Disease Physiology; Philosophy of Plant Pathology; Taxonomy of Fungi; Pathology of Trees and Shrubs.

Pomology—Tree Fruits; Orchard Management; Growth and Development of Woody Plants.

Rural Sociology—Rural Development and Cultural Change; Political Structure and Development; Social Power and Community Change; Political Economy of Rural and Regional Development.

For detailed information please contact the Office of Academic Programs.

Course Offerings

Graduate students at the College of Environmental Science and Forestry have not only the academic and research resources of their own institution, but also the resources of nearby Syracuse University and State University Upstate Medical Center.

In graduate programs at the College, Syracuse University courses are used extensively in the fields of mathematics, physics, chemistry, biology, engineering, economics, business and citizenship. The State University Upstate Medical Center has courses available for graduate programs in the areas of anatomy, biochemistry, cytology, microbiology and physiology.

COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY COURSE DESCRIPTIONS

The courses offered by the College are grouped by general subject areas, and the number of credit hours appears after the course title. A credit hour means one recitation (or lecture) hour per week. Three laboratory hours are equivalent to one lecture hour.

The semester and year after each course indicates when it will next be offered. The College reserves the right to alter the scheduled offering of a course when its enrollment is too small, or when there is no qualified faculty member available to teach it.

Course Numbering System

Code Levels:

500-599 Graduate courses designed expressly for graduate students, in areas supporting their specialization or interdisciplinary program, or for fifth year professional students with baccalaureate degrees (e.g., BLA students with B.S. in Environmental Studies), and available for undergraduate credit by selected upper division undergraduate students with superior academic records.

600-699 Graduate courses designed for beginning graduate students. Undergraduates are permitted admission only by petition with a well-documented justification approved by the undergraduate advisor and curriculum director and the instructor of the course.

700-899 Advanced graduate courses designed primarily for second and third year graduates and beyond, but available to all graduates.

900-999 Special graduate courses available only to doctoral students.

APPLIED MATHEMATICS (APM)

500. Introduction to Computer Programming for Graduate Students (3)
This basic course in computer use offered by the College is intended to provide the student with the skill and understanding needed to utilize digital computer languages for problem solving. The course includes a rather detailed study of Fortran IV, plus some discussion of an Assembly language and moderate study of Cobol and APL. To provide completeness, some attention is also afforded to techniques of representing information, managing files, error control and to operating systems and job control. This course or a demonstrated equivalent is a prerequisite to individual student use of the College computer facilities. Fall and Spring, 1978-79.

605. Theory of Probability Distributions (1-3)
Three hours of weekly sessions over 5-14 weeks. Statistical problems and mathematical models; random experiments, random variables, probability, frequency and distribution functions of discrete, continuous and mixed random variables; functions of random variables and the probability distributions; mathematical expectation and its applications; discussion of the main theoretical distributions such as binomial, Poisson, negative binomial, normal, Gamma, Beta, exponential and others; applications of this framework to the model construction problem in the statistical, operations research and forest mensuration areas. Fall or Spring, 1978-79.

Prerequisites: Two semesters of differential and integral calculus and an introductory course in statistics, or permission of the instructor. The course can be taken in conjunction with APM 651—Operations Research I (for 1 credit hour) or independent of it for 1 to 3 credit hours.

610. Statistical Analysis (3)
Two hours of lecture and 3 hours of lab. A treatment of statistical inference, including paired design, group design, linear regression and correlation, one way analysis of variance and some applications of chi-square. Calculation of statistics, tests of hypotheses and proper interpretation of calculated statistics. Fall, 1978.

620. Analysis of Variance (3)
Three hours of lecture and recitation and 3 hours of lab. Multiway classifications in the analysis of variance, with emphasis on the development of models, including randomized blocks, latin squares, split plots, and factorial designs with fixed effects, random effects, and mixed effects; multiple and partial regression and correlation (including curvilinear), using matrix methods; analysis of co-variance. Fall, 1978.

Prerequisite: Graduate standing and an introductory course in statistics covering material through the one-way analysis of variance.

625. Introduction to Sampling Techniques (3)
Two hours of lecture and 3 hours of lab. Introduction to the scientific basis of sampling: selecting an appropriate sampling unit; choosing an efficient design; calculating sampling error; determining a sample size to meet stated objectives. Spring, 1979.

Prerequisite: APM 391 or equivalent.

630. Regression Techniques with Applications to Forestry (3)
Two 1½ hours of lecture per week. Review of matrix algebra, probability theory and statistical methods. Basic concepts in regression analysis. Classical linear regression model. Least and weighted least squares method. Dummy variables and their uses in regression and covariance analysis. Applications to problems of statistical prediction and estimation from the field of forestry in general and forest mensuration and inventory in particular. Fall, 1978.

Prerequisite: APM 391 or equivalent.

635. Multivariate Statistical Methods (3)
Estimation and inference for the multivariate normal distribution. Multivariate analysis of variances, factor analysis, principal components analysis, canonical correlation, discriminant analysis, cluster analysis. Spring, 1979.

Prerequisite: One semester of statistics.

651. Operations Research I **(3)**
Two 1½ hours of lecture. Stochastic OR models applicable to managerial process or systems analysis. Elements of probability theory, theory of games and decision theory, queuing model, simulation techniques with applications to queuing and inventory problems, and, if time permits, Markov chains. Fall, 1978.
Prerequisites: APM 391 and MAT 227 or equivalent.

652. Operations Research II **(3)**
Two 1½ hours of lecture. Deterministic OR models applicable to managerial problems or systems analysis. Elements of Matrix Algebra, solving simultaneous linear equations, mathematical programming, classical optimization techniques, Lagrange multipliers. Linear programming transportation and allocation models, dynamic programming, network analysis and, if time permits, quadratic, parametric and integer programming. Spring, 1979.
Prerequisites: APM 391 and MAT 227 or equivalent.

EIN—ENVIRONMENTAL INFLUENCES (LANDSCAPE ARCHITECTURE)

510. Creative Problem Solving Seminar **(3)**
Three hours of lecture and discussion per week. A course designed to extend the students understanding and application of creative problem solving process. One requirement will be to select and carry out an application of the techniques to a particular problem, with consultation and guidance from the instructor. Critique and survey of the literature on creativity, in-depth analysis of the synectics process and various procedures which have been developed for nurturing creative behavior comprise the essence of the program.
Prerequisites: Undergraduate degree or permission of instructor. Fall, 1978.
Note: EIN 510 is also listed as SCE 510.

ENVIRONMENTAL SCIENCE (ENS)

797. Environmental Science Seminar **(1-2)**
Discussion of current topics and research related to environmental science. Fall and Spring, 1978-79.

798. Problems in Environmental Science **(Credit hours to be arranged)**
Specialized study in the problem areas of Environmental Science for graduate students. Tutorial conferences, discussions, seminars, workshops, and critiques scheduled as necessary. Comprehensive report required for some subjects. Fall and Spring, 1978-79.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

ENVIRONMENTAL AND RESOURCE ENGINEERING (ERE)

563. Photogrammetry I **(3)**
Two hours of lecture and discussion, 3 hours of laboratory and discussion. Basic photogrammetric and photo interpretation concepts as a means of acquiring reliable data for engineering and management planning. Potentials, limitations, instrumentation and unique requirements are considered. Fall and Spring, 1978-79.
Prerequisite: FEG 271 (or FEG 371 concurrent) or equivalent.

596. Special Topics **(1-3)**
Lectures, conferences, discussions and laboratory. Topics in environmental and resource engineering not covered in established courses. Designed for the beginning graduate student or selected upper division undergraduate. Fall and/or Spring, 1978-79.

611. Energy: Production and Conservation **(3)**
Three hours lecture. An introductory graduate level course dealing with the forms and impacts of energy production and conservation. A review of basic mechanics and thermodynamics is related to heat and energy conversion fundamentals for a variety of fuel and energy resources, with special attention to biomass conversion focus on the residential/commercial sector. Field trips and student reports are required. Fall or Spring, 1978-79.

640. Water Resource Systems **(3)**
Three hours of lecture and discussion per week. Fundamentals of the systems approach to complex water resource problems. Characteristics of water resource systems, related to systems engineering methodologies. Quantitative and qualitative subsystems are considered in a technical nature which exposes the socio-legal-political interfaces of water resource decisionmaking. Fall and/or Spring, 1978-79.
Prerequisite: FEG 340 or equivalent.

643. Water Pollution Engineering **(3)**
Two hours of lecture and 3 hours of laboratory. Introduction to the physical, chemical, and biological parameters of waste water treatment processes and to the principles of the unit operations involved. Study of the design parameters and design procedures of waste water treatment systems. Fall, 1978.
Prerequisites: PHY 211, CHE 356 or permission of instructor.
Note: A student may not enroll in or receive credit for both ERE 440 and ERE 643.

652. Remote Sensing Interpretation **(3)**
Two hours of lecture and 3 hours of laboratory per week. Introduction with a qualitative emphasis to the fundamentals of acquiring, analyzing and utilizing remote sensing data in the performance of natural resource inventories, environmental quality surveys, site development studies and land use analyses. Oriented for multidisciplinary participation. Fall and/or Spring. (Not open to students having previous credit for FEG 352). 1978-79.
Prerequisites: Physics and calculus or consent of instructor.

655. Remote Sensing Measurements **(3)**
One hour of lecture, 1 hour of discussion and 3 hours of laboratory comprising an in-depth coverage of the theory, design and application of remote sensing systems and techniques employed to obtain precise spectroradiometric measurements in vegetation surveys, site engineering, data acquisition endeavors and environmental monitoring efforts. Photographic and nonphotographic systems are considered. A variety of field and laboratory measurement endeavors employing precision remote sensing equipment is included. Fall or Spring, 1978-79.
Prerequisites: FEG 352, ERE 652, and FEG 363, ERE 563 or consent of instructor.

658. Geometric Geodesy **(3)**
An introductory graduate level course for those without previous background in theoretical geodesy. Topics covered include position determination for short and long lines on the ellipsoid, the ellipsoidal triangle, the parametric equations, three-dimensional geodesy, and mappings of the ellipsoid. Fall, 1979.
Prerequisite: Permission of the instructor.

659. Astronomic and Gravimetric Geodesy **(3)**
An introductory graduate level course in geodetic astronomy and the gravity field of the earth. Topics covered include updating star positions; precise time keeping; position determination by natural and artificial satellites; the fundamental concepts of gravimetric geodesy, including the potential function; attraction; undulations of the geoid and deflections of the vertical. Fall, 1979.
Prerequisite: ERE 674.

660. Theory of Errors and Adjustments **(3)**
The theory of errors and adjustment of observations oriented toward geodesy and photogrammetry. Topics include error definitions, weighted observations, method of least

squares, matrix algebra in adjustments, variance-covariance matrix, the error ellipse and the general case of adjustment. Fall or Spring, 1978-79.

Prerequisite: Calculus; a beginning course in statistics.

664. Photogrammetry II **(3)**

Mathematical theory of photogrammetry including space resection, orientation and intersection. The theory and use of photogrammetric analogue computers in providing resource engineering maps. Fall, 1978.

Prerequisite: ERE 563 or equivalent.

670. Principles of Pulping and Bleaching **(3)**

Two hours of lecture and 3 hours of laboratory plus literature study of assigned topics, independent project planning/or laboratory study. Discussion of pulping and bleaching processes. Effects of chemical and physical variables on the wood components and pulp properties; chemistry involved. Experiments in pulping and bleaching and pulp evaluation. Fall, 1978.

Prerequisites: Organic, physical, and analytic chemistry.

Note: A student may not enroll in or receive credit for both PSE 461 and ERE 670.

675. Principles of Unit Operations **(4)**

Fundamentals of fluid dynamics, heat and mass transfer, appropriate analogies and process applications. Stage operations and computation methods. Application to distillation, extraction, gas absorption, evaporation, crystallization and drying. Design, operation and computer simulation of equipment. Three hours of lecture-discussion and one two-hour computation period per week. Fall, 1978.

Prerequisites: Calculus and physical chemistry, or permission of instructor.

677. Paper Properties **(4)**

Three hours of lecture, 3 hours of laboratory and discussion plus evaluation of literature, independent project planning and/or laboratory study. Evaluation and study of the physical, optical and chemical properties of paper and the inter-relationships existing between paper manufacturing methods, papermaking additives, test results and the ultimate properties desired in the finished paper. Fall, 1978.

Prerequisite: Consent of instructor.

Note: A student may not enroll in or receive credit for both PSE 465 and ERE 677.

678. Paper Coating and Converting **(3)**

Two hours of lecture and 3 hours of laboratory plus evaluation of literature, independent project planning, and/or laboratory study. Evaluation and study of the various coating materials and processes used by the paper industry. Introduction to polymers and their use in converting operations. Study of materials and equipment used in converting operations, fundamentals and parameters which control their use, effects on final properties of papers. Spring, 1979.

Prerequisite: PSE 465 or consent of instructor.

Note: A student may not enroll in or receive credit for both PSE 466 and ERE 678.

680. The Anatomy and Ultrastrvctvre of Wood **(2)**

Two hours of lecture and/or demonstration and discussion. The gross, microscopic and submicroscopic structure of wood including organization of the cell wall, distribution of chemical constituents and abnormalities in wood. Fall, 1979.

Prerequisites: None.

682. Transport Processes **(3)**

Two hours of lecture and 3 hours of laboratory. The relationship between wood structure and wood permeability, moisture movement, and heat transfer. Fire retardant and woodpreservation treatments. Wood drying. Unsteady-state transport processes. An advanced laboratory problem with report in wood-moisture relationships, wood drying, the relationship between wood permeability and treatability, or wood preservative treatments. Spring, 1979.

Prerequisite: Permission of instructor.

684. Mechanical Properties of Wood (3)
Two hours of lecture and 3 hours of laboratory. The effect of the anatomical and chemical nature of wood on its response to static and dynamic force systems. The theory of elasticity as applied to wood. Fall or Spring, 1978-79.
Prerequisite: Permission of instructor.

685. Applied Electron Microscopy (3)
Two hours of lecture and/or demonstration and 3 hours of laboratory. The theory and operation of the transmission electron microscope including specimen preparation, photographic technique and interpretation of micrographs. Fall, 1978.
Prerequisite: Consultation with instructor advised.

686. Wood-Water Relationships (3)
Two hours of lecture and 3 hours of laboratory. Relationship between wood moisture content and its environment, electrical properties, theories of moisture sorption, hygroscopic swelling and shrinking, thermodynamics of moisture sorption, mechanism of moisture movement. Fall, 1979.
Prerequisite: Consent of instructor.

688. Tropical Timbers in Commerce (2)
Two hours of lecture. Introduction to the commercial use of tropical timbers; the factors of forest conditions, stand types and wood qualities influencing their utilization and the development of trade. Sources of information. Spring, 1979.
Prerequisite: Permission of instructor.

689. Tropical Wood Anatomy (1)
Anatomical characters, identification and taxonomy of tropical woods important in commerce. Spring, 1979.
Prerequisite: WPE 386 or 387. Recommended that ERE 688 be taken concurrently or previously.

691. Air Pollution Engineering (3)
Three hours of lecture and discussion. Study of the chemical, physical, and meteorological principles of air pollution and its control. Local and global effects of air pollution. The atmospheric survey. Examination of the operating principles and design parameters of the various air pollution control systems. Air quality and emission standards, Spring, 1979.
Prerequisites: PHY 211 and CHE 356 or permission of instructor.
Note: A student may not enroll in or receive credit for both ERE 441 and ERE 691.

760. Analytical Photogrammetry I (3)
Two hours of lecture and 3 hours of laboratory per week. Mathematical theory of photogrammetry including space resection, orientation, intersection and aerial triangulation. Fall or Spring, 1978-79.
Prerequisites: FEG 363 and APM 360 or equivalent.

762. Instrumental Photogrammetry I (3)
Two hours of lecture and 3 hours of laboratory. The theory and practice of extracting information from photographs with the aid of photogrammetric plotters. Fall or Spring, 1978-79.
Prerequisite: FEG 363 or equivalent.

775. Applied Thermodynamics (3)
The study and application of thermodynamics, including the first and second law, phase relationships, thermochemistry, the production of work and equilibrium relationships. Fall or Spring, 1978-79.
Prerequisites: CHE 346, CHE 356, or equivalent.

796. Advanced Topics (1-3)
Lectures, conferences, discussions and laboratory. Advanced topics in forest engineering, paper science and engineering, and wood products engineering. Fall and/or Spring, 1978-79.
Prerequisite: Consent of instructor.

797. Seminar **(1-3)**
I. Forest engineering topics. II. Paper science and engineering topics. III. Wood products engineering topics. Fall and Spring, 1978-79.

798. Research in Environmental and Resource Engineering **(Credit hours to be arranged)**
I. Independent research topics in forest engineering. II. Independent research topics in paper science and engineering. III. Independent research topics in wood products engineering. Fall and Spring, 1978-79.

880. Interpretation of Cellular Ultrastructure **(2)**
One hour of lecture and 2 hours of demonstration and discussion. The organization and sculpturing of the walls of plant cells; the cellulose microfibril, matrix and incrusting substances, and the warty layer. The ultrastructure and general function of cytoplasmic organelles in cells. The tools and techniques used for light and electron microscopic study of cells, and the interpretation of structural evidence. Directed study and discussion of the latest (current) literature on pertinent topics. Spring, 1979.
Prerequisite: Permission of the instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

FOREST BIOLOGY (FBL)

500. Forest Biology Field Trip **(2)**
A 7 to 10 day trip to (1) agencies engaged in biological research, management and administration, or (2) regions or areas of unusual biological interest. A final report is required. Estimated student expense, $75.00. Fall or Spring, 1978-79.
Prerequisite: Permission of instructor.

522. Populations Ecology I **(3)**
Two hours of lecture and 3 hours of laboratory per week. Description, analysis, evolution, interactions and stability of natural and experimental populations. Spring, 1979.
Prerequisite: FBL 320 or equivalent.

525. Limnology **(3)**
Three hours of lecture. An introduction to the physics, chemistry and biology of inland waters, with particular emphasis on lakes. The course focuses on lakes as integrated ecosystems and analyzes perturbations in this environment on the structure and function of the biological communities contained therein. Fall, 1978.
Prerequisites: An introductory course in physics, chemistry, and ecology.

526. Limnology Laboratory **(1)**
One laboratory or field trip/week. An introduction to Limnology techniques and the taxonomy of aquatic organisms. Field trips to local aquatic habitats. FBL 525 must be taken concurrently or previously. Fall, 1978.

540. Chemical Ecology **(3)**
Two hours of lecture and 1 hour of discussion. A treatment of biological phenomena incorporating elements of ecology, physiology and chemistry as a basis for development, behavior and survival. Emphasis is on the mntra- and inter-specific relationships involving chemical messengers at the organismal, population and community levels. Spring, 1979.
Prerequisites: Organic chemistry, general ecology, general physiology.
Note: FBL 540 is also listed as FCH 540.

622. Population Ecology II
Two hours of lecture and 1 hour of seminar. An advance course in population ecology emphasizing the dynamics of insect and plant populations. Spring, 1979.
Prerequisite: FBL 522 or permission of instructors.

670. Cytogenetics **(3)**
Two hours of lecture and 1 hour of seminar and discussion. Structure and behavior of chromosomes in animals and plants are considered. The effects of chromosomal aberrations and abnormal chromosome numbers on somatic and germ cell divisions, on the physiology and development of organisms with emphasis on human diseases and on populations including structure, speciation and evolution are discussed. Lecture demonstrations include tissue culture and cell hybridization methods for karyo-type analyses and somatic cell genetics. Fall (odd calendar years). Fall, 1979.
Prerequisite: FBL 470 or permission of the instructors.

785. Histochemical Techniques **(3)**
One lecture and two labs. The techniques of the microtomecryostat, freeze-drying and freeze substitution, histochemical stains, and autoradiography in the elucidation of the constitution of cells and tissues. Spring (even calendar years), 1980.
Prerequisites: Microtechnique and organic chemistry.

796. Topics in Biology **(1-3)**
A course offered by the faculty for students interested in biology. Check the Schedule of Courses for details. Fall and Spring, 1978-79.

835. Membranes and Biological Transport **(3)**
Two hours of lecture and 1 hour of discussion. Composition, structure, and physical properties of membranes. Membrane functions including transport, bioelectricity and cell compartmentalization. Specific transport processes in biological systems. Fall (alternate years), 1978.
Prerequisites: One semester of biochemistry and an advanced physiology course, or permission of the instructor.

997. Biology Seminar **(1)**
One hour of lecture-discussion per week. The course emphasizes current concepts and developments in biology. Fall and/or Spring, 1978-79.

BOTANY (BOTANY AND FOREST PATHOLOGY) (FBO)

510. Mycology **(5)**
Three hours of lecture and 6 hours of laboratory. Fundamentals of the morphology, taxonomy, cytology, life histories and ecology of fungi. Laboratory experience in culturing and identifying fungi. Fall, 1978.
Prerequisite: FBO 310 or FBO 360.

515. Systematic Botany **(3)**
Two hours of lecture and 3 hours of laboratory. Identification, nomenclature and classification of flowering plants with special emphasis on local flora and on developing the ability to classify the plants of any region. Fall, 1978.
Prerequisite: FBO 310 or permission of the instructor.

530. Plant Physiology **(2)**
Two hours of lecture. Internal processes and conditions in higher plants with emphasis on physiological and biochemical concepts. For students majoring in the biological sciences. Spring, 1979.
Note: Botany majors electing this course for their concentration must also take FBO 531.

531. Plant Physiology Laboratory **(2)**
Two lab sessions. Introduction to current methods and procedures of physiological research including nutrition, tissue culture, photosynthesis, respiration and hormonal regulation of growth. Spring, 1979.
Prerequisites: FBL 330, corequisite FBO 530, or permission of the instructor.

562. Wood Microbiology **(3)**
Two hours of lecture and 3 hours of laboratory/field trip. Major types of fungus defects of wood and its products and principles of control. Special emphasis on chemistry of wood decay, wood durbility, toxicants, lumber discolorations, heart-rots and decay in forest products. Fall, 1978.
Prerequisites: Organic Chemistry, FBO 360, or consent of instructor.

585. Plant Anatomy **(3)**
Two hours of lecture and 3 hours of laboratory. An introductory course in plant anatomy designed to familiarize the student with the organization and development of the primary and secondary plant body of higher plants. Spring, 1979.
Prerequisite: FBO 100.

625. Plant Ecology **(3)**
Two hours of lecture and discussion and one laboratory/discussion section per week. A first course in plant community ecology for beginning graduate students focusing on dynamics of community development and change and the processes of community analysis and description. Spring, 1979.
Prerequisite: A course in general ecology.

630. Fungus Physiology **(3)**
Two hours of lecture and 1 hour of discussion. Principles of growth, reproduction and differentiation of the fungi emphasizing the role of the environment in controlling fungal processes. Spring (even years), 1980.
Prerequisites: Two semesters of physiology or biochemistry.

636. Photosynthesis **(3)**
Two hours of lecture and 1 hour of discussion. Advanced study of photosynthesis on the cellular and organismal level. Specific topics will reflect basic concepts and current emphasis in this field. Fall (odd years), 1979.
Prerequisite: Two semesters of physiology or a course in biochemistry.

660. Phytopathology **(3)**
Two hours of lecture and discussion and 3 hours of auto-tutorial laboratory. Principles and concepts of plant pathology. Major diseases of ornamental plants, vegetable crops, fruit crops, field crops and trees. This is an introductory plant pathology course for graduate students in all departments. Spring, 1979.

661. Principles of Forest Pathology **(3)**
Four hours of lecture, discussion and laboratory. Concepts and principles of tree diseases in relation to forest practices and practical experience in disease diagnosis and impact evaluation. Fall, 1978.
Prerequisite: FBO 360, 660, or consent of instructor.

665. Principles and Practices of Tree Disease Control **(3)**
Two hours of lecture and 3 hours of laboratory or discussion per week. An advanced course considering the major chemical, cultural, and biological practices and related strategies for tree disease control. Spring semester, 1979.
Prerequisites: FBO 510, 461, or consent of instructor.

715. Advanced Systematic Botany **(2-3)**
Lectures and laboratory. Field trips. Advanced study in the identification, nomenclature, and

classification of flowering plants. Special emphasis on Gymnospermae, Compositae, and Gramineae. Spring (even years), 1980.
Prerequisite: FBO 515 or equivalent.

725. Topics in Plant Ecology (2)
Two hours of seminar-discussion. An advanced course dealing with current research in plant community dynamics. May be repeated for additional credit. Fall, 1978.
Prerequisite: FBO 425 or 625 or consent of instructor.

733. Techniques in Plant Physiology (2-4)
Comprehensive study of techniques essential for research in plant physiology. Students may choose the instructors they wish to work with, and should consult the instructors for further details. Fall of every year. May be repeated for credit in different specialties. Fall, 1978.
Prerequisites: FBO 530 and 531 or an equivalent physiology course, biochemistry with laboratory, or consent of the instructor.

761. Topics in Phytopathology (3)
Two 2-hour lecture-discussions. Discussions of specific subjects in phytopathology and wood microbiology. Topic selection is based on availability of expertise and will be announced in advance.This course may be repeated for credit in different specialties. Fall or Spring, 1978-79.

FBO 763. Mycorrhizae (3)
Two hours of lecture and 3 hours of laboratory/discussion per week. A basic background course covering structural, functional, and ecological aspects of mycorrhizae; their methods of field and laboratory study; and applications in forestry practice. Course offered in odd years. Fall, 1979.

797. Botany Seminar (1)
Seminar discussions of subjects of interest and importance to the biology of plants. Fall and Spring, 1978-79.

798. Research in Forest Botany (Credit hours arranged according to nature of problem)
Advanced study in research problems in forest pathology, wood deterioration, tree physiology, anatomy, mycology, ecology, taxonomy and genetics. Typewritten report required. Fall and Spring, 1978-79.

810. Advanced Mycology, Homobasidiomycetes (3)
Review of selected literature as well as laboratory training in identification and research techniques. Fall, 1979.
Prerequisite: FBO 510. Course offered in odd years.

811. Advanced Mycology, Heterobasidiomycetes (3)
Review of selected literature as well as laboratory training in identification and research techniques. Spring, 1980.
Prerequisite: FBO 510. Course offered in even years.

812. Advanced Mycology, Ascomycetes (3)
Review of selected literature as well as laboratory training in identification and research techniques. Fall, 1978.
Prerequisite: FBO 510. Course offered in even years.

813. Advanced Mycology, Myxomycetes, Phycomycetes, Fungi Imperfecti (3)
Review of selected literature as well as laboratory training in identification and research techniques. Spring, 1979.

830. Physiology of Growth and Development **(2)**
Lecture. A study of the growth and development of plants and the physiological and biochemical processes that influence the development of form and structure in higher plants. Fall (even years), 1978.
Prerequisites: FBO 530, 585, and organic chemistry or permission of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

CHEMISTRY (FCH)

510. Aquatic Environmental Chemistry **(3)**
Three hours of lecture. Includes discussion of structure of water, its physical and biological chemistry, water treatment problems, nutrient cycles, trace organic pollutants, and the environmental chemistry of air/water and sediment/water interfaces. Fall, 1978.

520. Nuclear and Radiation Chemistry **(2)**
The two 1-hour lectures will cover the information required for the basic understanding of nuclear reactions, the types of radiation emitted, the instrumentation necessary to detect and measure this radiation, the principles of radioisotope tracer techniques and radiation chemistry which is the effect of radiation on organic systems. Visits to the Cornell Reactor and the Nuclear Medicine Department of the Upstate Medical Center will be arranged. Spring, 1979.
Prerequisites: Physical, organic and inorganic chemistry or by permission of the instructor.
Note: This course can be taken independently of FCH 521.

521. Nuclear Chemical Techniques **(1)**
The laboratory will consist of one 4-hour laboratory class every 2 weeks, with 1 hour to be made up at the student's discretion to accommodate counting periods which extend over several weeks. A short movie by the AEC each week will be required for the sixth hour. The laboratory will give each student the opportunity to use the individual counting instruments, gain experience in the handling and preparation of radioactive samples and the use of the 1000-curie-cobalt source in radiation chemistry. Spring, 1979.
Prerequisite: Physical, organic and inorganic chemistry or permission of the instructor. Advanced tentative registration is required.
Corequisite: FCH 520.

530. Biochemistry I **(3)**
Three hours of lecture. General biochemistry with emphasis on cellular constituents and metabolic reactions. The chemical, physical and biological properties of amino acids, proteins, carbohydrates and their intermediary metabolism will be discussed. The chemistry of enzymes, energy transfers and biological oxidations will also be covered. Fall, 1979.
Prerequisite: One year of organic chemistry.
Pre- or corequisite: One year of physical chemistry.

531. Biochemistry Laboratory **(2)**
Six hours of laboratory. This course will stress techniques used in biochemical research. Techniques used include various types of chromatography, electrophoresis, and spectrophotometry and methods involved in the isolation, purification and assay of enzymes. Fall, 1978.
Prerequisite: One semester of quantitative analysis with laboratory.

532. Biochemistry II **(3)**
Three hours of lecture. Topics discussed are: application of tracer techniques to biochemistry, the chemical and biochemical properties of lipids, theories on the origin of life,

photosynthesis and the biosynthesis of steroids and terpenes, plant aromatics, amino acids, porphyrins and other aspects of nitrogen metabolism. Spring, 1979.
Prerequisites: FCH 530 and its pre- and corequisites.

539. Principles of Biological Chemistry **(3)**
Three hours of biochemistry with emphasis on their relationship to biology. Topics include basic metabolic pathways, structure and function of proteins, enzymes, and nucleic acids, energy relationships and biochemical control mechanisms. Fall, 1978.
Prerequisite: A 2-semester course in organic chemistry is desirable, but a 1-semester course is acceptable. This course is not open to chemistry majors.

540. Chemical Ecology
This course is the same as FBL 540. Refer to description on page 73.

551. Polymer Techniques **(2)**
One hour of lecture and discussion and 3 hours of laboratory; lab reports. Techniques of polymer preparation: free radical solution and emulsion polymerization, copolymerization. Molecular weight determination by light scattering, osmometry, viscosity, ultracentrifugation. Structure characterization by X-ray diffraction, electron microscopy, nuclear magnetic resonance, optical rotatory dispersion, polarized microscopy, stress-strain and swelling equilibrium. Fall, 1978.
Prerequisites: One year of organic and 1 year of physical chemistry.

552. PolymerQrocessing and Technology **(3)**
Industrial methods of production and processing of polymeric materials such as fibers, films, plastics, elastomers, foams, composites, adhesives and coatings, including discussions on the correlation between polymer structure and polymer properties. Spring, 1979.

630. Plant Biochemistry **(3)**
Three hours of lecture and discussion. Includes the biochemistry of photosynthetic electron transport and phosphorylation, photosynthetic carbon fixation, photorespiration, nitrogen fixation, nitrate reduction, photochrome and plant hormones. The economic, ecological and environmental aspects of plant biochemistry will also be discussed. Spring, 1979.
Prerequisite: FCH 530—532 or FCH 539 or equivalent.

650. Physical Chemistry of Polymers I **(3)**
Three hours of lecture. Includes: thermodynamics of polymer solutions, phase equilibria, fractionation, structure-property relationships, elementary chain statistics, molecular geometry, network elasticity, polyelectrolyte theory and viscosity. Fall, 1978.
Prerequisites: One year of organic chemistry and 1 year of physical chemistry.

651. Physical Chemistry of Polymers II **(3)**
Three hours of lecture. Viscoelasticity. The glassy state and glass transition temperature. The crystalline state and crystallization kinetics. Characterization of structure and morphology of polymer solid states. Survey of structure and properties of native polymers. Spring, 1979.
Prerequisites: One year of organic and 1 year of physical chemistry.

652. Organic Chemistry of Polymers I **(3)**
Three hours of lecture. A broad survey of the chemistry of polyfunctional molecules and methods for their conversion to high molecular weight materials. Synthesis of a variety of specialty polymers and chemical reactions on natural and synthetic polymers. Some relations between molecular structure and useful properties. Fall, 1979.
Prerequisite: One year of organic chemistry.

653. Organic Chemistry of Polymers II **(3)**
Three hours of lecture. Kinetics and mechanism of polymerization processes, with emphasis on additional homo- and copolymerization relations initiated by radical, cationic and anionic initiators. Mechanism of stereospecific polymerization. Structure of polymers. Reactions on polymers and their modification for specific end uses. Block and graft polymers. Spring, 1979.
Prerequisites: One year of organic chemistry and one year of physical chemistry.

681. Principles of Physical Chemistry **(2)**
Two hours of lecture. Includes advanced discussions on thermodynamics, chemical equilibrium, kinetic theory, chemical kinetics, and electrochemistry. Spring, 1979.

682. Principles of Organic Structure and Synthesis **(3)**
Three hours of lectures and discussion. A broad survey of strategies for constructing organic molecules and of physical and chemical methods for the elucidation of structure. Emphasis on material relevant to different chemical disciplines. Fall, 1979.
Prerequisite: One year of organic chemistry.

796. Special Topics in Chemistry **(1-3)**
(Credit hours arranged according to nature of topic)
Lectures, conferences and discussion. Advanced topics in physical chemistry, organic chemistry, or biochemistry. Fall and Spring, 1978-79.

798. Research in Chemistry (Credit hours arranged according to nature of problem)
Independent research in physical and organic chemistry of synthetic polymers, physical and organic chemistry of natural polymers, organic chemistry of natural products, ecological chemistry and biochemistry. One typewritten report required. Fall and Spring, 1978-79.

884. Organic Natural Products Chemistry **(3)**
Three hours lecture. The chemistry of terpenoids, steroids and alkaloids with an emphasis on the determination of structure by both modern instrumental methods and chemical degradation. Biogenetic considerationsnd the confirmation of structure by synthesis are covered. Fall or Spring, 1978-79.
Prerequisite: One semester of advanced organic chemistry.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

997. Seminar **(1)**
Seminars scheduled weekly; an average of twenty to thirty seminars are given annually. Discussion of recent advances in chemistry. Credit is given only once to a student. Fall and Spring, 1978-79.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

ENTOMOLOGY (FOREST ENTOMOLOGY) (FEN)

510. Arachnology **(3)**
Two hours of lecture/discussion and 3 hours of laboratory. Introduction to biology and ecology of spiders, mites, scorpions and other arachnid groups. Laboratories emphasize classification and identification of specimens. Spring (even years), 1980.
Prerequisite: Course in General Entomology or Invertebrate Zoology.

560. Environmental Toxicology of Insecticides **(2)**
Two hours of lecture. Basis of action of insecticides in living systems, behavior of insecticides and microtoxicants in environment, interaction of insecticides and biological systems. Fall, 1978.
Prerequisite: FBL 330 or equivalent course in physiology or biochemistry.

580. Insect Morphology **(3)**
Two hours of lecture and 3 hours of laboratory. A comparative study of the external morphology of insects emphasizing evolutionary trends, especially modifications of homologous

structures. Topics of special importance include intersegmental relationships, feeding, sensory mechanisms, locomotion and reproduction. Spring, 1979.
Prerequisite: FEN 350.

610. General Insect Taxonomy **(3)**
Two hours of lecture and 3 hours of laboratory. Identification and classification of the important orders and families of insects; acquaintance with pertinent taxonomic literature and use of keys; and understanding of evolutionary principles and concepts and a knowledge of systematic theory and practice. Insect collection required. Fall, 1978.
Prerequisites: FEN 350, FEN 580.

620. Aquatic Entomology **(3)**
Two hours of lecture and 3 hours of laboratory. The biology, ecology and identification of fresh water insects, with emphasis on the role of aquatic insects in the hydrobiome. Fall, 1978.
Prerequisite: FEN 350 or its equivalent.

630. Insect Physiology **(3)**
Two hours of lecture and 3 hours of laboratory. Study of the life processes in insects; introduction to modern physiological instrumentation and laboratory methods. Spring, 1979.
Prerequisite: FBL 330.

650. Histological Techniques **(2)**
Two 3-hour laboratories. A study of the series of actions involved in preserving insect tissue through fixation, embedding and staining and the process of observing and identifying tissue sections through microscopic analysis. Fall (even years), 1978.
Prerequisite: By permission of instructor.

660. Insecticide Toxicology Laboratory **(2)**
One hour of discussion and 3 hours of laboratory. Laboratory experiments in mode of action and behavior of insecticides, biological and instrumental analysis of insecticides including tracer analyses. Spring (odd years), 1979.
Prerequisites: FEN 560 or equivalent and consent of instructor.

796. Special Topics in Forest Entomology
(Credit hours arranged according to nature of work)
Special instruction, conference, advanced study, and research projects in the fields of insect toxicology, insect physiology, taxonomy of immature insects, phases of biology and ecology of insects. Typewritten report required in some fields. Fall and Spring, 1978-79.

797. Seminar **(1)**
One hour of conference per week. Assigned reports and discussion of topics in entomology. Fall and Spring, 1978-79.

798. Research Problems in Forest Entomology
(Credit hours arranged according to nature of problem)
Comprehensive report required in some projects. Fall and Spring, 1978-79.

810. Advanced Insect Taxonomy **(3)**
Two hours of lecture and 3 hours of laboratory. Methods, procedures and concepts of systematics. Examples and material will be drawn from among important groups of forest insects. Fall, 1978.
Prerequisites: FEN 580 and FEN 610.

820. Taxonomy of Diptera **(3)**
One hour of lecture-discussion, 6 hours of laboratory. Methods and procedures for collecting, preserving and determining generic and specific identifications of adult and larval flies will be practiced. Problems and concepts of Diptera systematics will be discussed. Fall (even years), 1978.
Prerequisites: FEN 350, FEN 580, FEN 610; FEN 810 suggested.

860. Advanced Toxicology of Insecticides **(3)**
Three hours of lecture and discussion. Review of current topics in toxicology of insecticides and related foreign compounds. Fall, 1978.
Prerequisites: FEN 560, FCH 530 **and** consent of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

FOREST ZOOLOGY (FZO)

520. Terrestrial Community Ecology **(3)**
Three hours of lecture. Relation of terrestrial vertebrates and invertebrates to their physical, chemical and biological environment. Emphasis on community principles, structural quantification, and evolutionary processes of terrestrial animals. Fall, 1978.
Prerequisite: A course in basic ecology.

620. Invertebrate Symbiosis **(3)**
Two hours of lecture and one 3-hour laboratory. An introduction to the ecology and evolution of interspecific relationships of invertebrates. Spring (even years), 1980.
Prerequisites: FBL 320, FZO 411.

621. Practicum in Terrestrial Community Ecology **(1)**
Three hour laboratory period. Intensive practical application of ecological principles to the study of terrestrial animal communities. Includes experimental and field collection of data, quantifications, synthesis and final reporting. Fall, 1978.
Pre- or corequisite: FZO 520 or equivalent.

622. Ecological Energetics **(3)**
Two hours of lecture and 3 hours of laboratory or 1 hour of discussion. Investigation of the principles of energy flow in biological systems. Emphasizing understanding of energy transformations, energy budgets and energy structures of individual organisms, populations and ecosystems. Spring, 1979.
Prerequisite: A course in general ecology.

628. Vertebrate Population Ecology **(3)**
Two hours of lecture and one 3-hour laboratory per week. Fundamental parameters of population structure and change with emphasis on vertebrate species. Spring, 1979.
Prerequisite: A course in general ecology.

635. Behavioral and Physiological Ecology **(3)**
Two hours of lecture and 1 hour of discussion. An examination of the concepts of animal adaptations to ecological change from a behavioral point of view. Particular emphasis will be placed on the role the environment plays in shaping the behavior of a given species. Behavioral and physiological responses to environmental conditions will be treated as a continuum. Spring (odd-years), 1979.

650. Biology and Management of Waterfowl **(2)**
A consideration of the identification, life history, ecology and economic importance of waterfowl of the Atlantic Flyway. The management of local, flyway and continental waterfowl populations, including the establishment of hunting seasons, will be discussed. One Saturday field trip. Fall (odd years), 1979.

720. Topics in Soil Invertebrate Ecology **(3)**
Two 1-hour lecture-discussion periods and a 3-hour laboratory. Study of literature relating to soil invertebrate microcommunities; taxonomy, culturing and collection methods of soil fauna; student will conduct an individual research problem. Spring (odd years), 1979.

727. Seminar in Aquatic Ecology **(1)**
Two hours of lecture and discussion. A seminar to explore in some depth areas of current research in aquatic ecology. Fall (even years), 1978.
Prerequisite: Six credits in Aquatic Ecology.

750. Topics in Wildlife Biology **(1-3)**
Hours to be arranged. Group study of a wildlife management topic. Fall or Spring, 1978-79.
Prerequisite: Six credits of wildlife management courses.

797. Forest Zoology Seminar **(1)**
Two hours of discussion and assigned reports on current problems and new developments in forest zoology. Fall and/or Spring, 1978-79.

798. Problems in Forest Zoology **(Credit hours to be arranged)**
Hours to be arranged. Individual study of special problems in forest zoology. One typewritten report (original and one carbon) required. Fall and/or Spring.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

970. Topics in Animal Behavior **(2)**
Two hours of lecture and discussion. A seminar-type course designed to explore in depth selected and controversial subject areas in animal behavior. Fall or Spring, 1978-79.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

LANDSCAPE ARCHITECTURE (LSA)

The following 500-level courses are offered as part of the fifth-year BLA program. They may be taken by MLA students, but not for graduate credit.

522. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Studio problems, research, drafting and field trips. Concentration on complex urban problems. Concern for social and psychological considerations of the individual and large groups of people, their interaction and resultant forms of the environment. Spring, 1979.
Prerequisite: Permission of instructor.

524. Experimental Landscape Design Studio V **(16)**
Forty-eight hours per week. The articulation of the study proposal established mn LSA 425, as approved by faculty, through research, readings, field study with graphic and written documentation, and group discussion. Academic study in an off-campus location in an area of landscape architectural significance, as described and delineated in a student-prepared proposal approved by the faculty. Not available for graduate credit. Fall or Spring, 1978-79.
Prerequisites: LSA 425 or equivalent and LSA 423 or permission of instructor.

525. Landscape Design Studio VI **(4)**
Twelve hours of studio per week. Investigation of a problem in landscape architecture as proposed by the student and conducted with faculty advisor. Spring, 1979.
Prerequisite: Permission of instructor.

527. Landscape Design Studio VI **(4)**
Twelve hours studio per week. Studio problems, research, reports and field trips. Concentration on regional landscape problems, the techniques of their analysis and derivation of their significance to the practice of landscape design. Spring, 1979.
Prerequisite: Permission of instructor.

529. The Major Elements of Environmental Design **(3)**
Lectures, readings, discussions and studios. The course presents an introductory survey of environmental design methods and associated skills and techniques. While studio work is engaged, no design background is required. Fall, 1978.

532. Woody Plant Materials **(3)**
Three hours of lecture per week. Field study, lectures, slide presentations and readings. An elective course providing opportunity for extension of basic knowledge in the identification and design of woody plant materials in professional practice. Fall or Spring, 1978-79.
Prerequisites: LSA 533 and LSA 432 or permission of instructor.

533. Plant Materials **(3)**
Field trips and discussion. Ornamental woody plant identification. Observation and sketches of outstanding examples of planting design. Three weeks, Summer Session, 1979.
Prerequisite: Permission of instructor.

545. Professional Practice Studio II **(2)**
Three hours of studio and 1 hour of recitation per week. Studio problems research, discussion and recitation sessions on the processes and methods of office practice. Emphasis on all aspects of site-development. Spring, 1979.
Prerequisite: Permission of instructor.

547. Principles of Professional Practice **(2)**
Two hours of lecture per week. Lectures, assigned readings, reports, cost estimates, specifications, contracts, professional ethics, registration laws, professional practice. Spring, 1979.
Prerequisite: Upperclass standing.

595. Selected Readings in Landscape Architecture **(1-3)**
Exploration of selected readings in depth with individual independent study upon a plan submitted by the student and related to credit hours assigned. Upon approval of the instructor, the student may systematically investigate some subject area encountered in regularly scheduled courses or may initiate research on a variety of subject areas of determined relevance. Fall, Spring and Summer Session, 1978-79.
Prerequisite: 5th year status or permission of instructor.

598. Research Problem **(1-3)**
Independent study of selected areas of environmental interest. Emphasis on a self-disciplined study, development of procedures and techniques to be employed in environmental design and planning. Engagement with specific sites and problems as proposed for study by individual communities. Fall and Spring, 1978-79. Enrollment at periodic intervals throughout the semester.
Prerequisite: Permission of instructor.

620. Graduate Studio I **(4)**
Six hours of studio and two lecture/seminar hours per week. An examination and evaluation of the landscape architectural design process with an emphasis on the methodological variations which occur in its definition and application. A variety of projects, scales, and programs are employed as a vehicle for study of the design process. Fall, 1978.
Prerequisite: Permission of instructor.

650. Determinants of Urban/Regional Land Use Patterns **(3)**
Three hours of discussion per week. This course will provide an introduction to social science theories of urban and regional land use patterns. The nature of social, economic and political processes are explored in order to determine how the relationship of such factors effects the spatial development of the urban and regional environment. Understanding of these processes provides a basis for urban and regional planning. Fall, 1978.
Prerequisite: Permission of the instructor.

651. Process of Urban/Regional Planning **(3)**
Three hours of seminar per week. The purpose of this course is the introduction of planning as a process of decisionmaking and to familiarize graduate students with its scope and content. The course relies upon lectures and readings to develop introductory knowledge as well as seminars and discussions to cover the constitutional basis, tools, and techniques and the current directions of planning. Spring, 1979.
Prerequisite: Permission of instructor.

653. Environmental Land Use Planning **(3)**
An introduction to the interdisciplinary techniques and emphasis on environmental land use planning. Consideration of the underlying ecological and planning philosophies. Readings and discussions are used in order to familiarize students with the disciplines involved and the process of data analysis, synthesis and plan formulation. Case studies and research projects used to enhance understanding.
Prerequisite: Permission of instructor. Fall and Spring, 1978-79.

654. Urban/Regional Open Space Planning **(3)**
Three hours of seminar per week. An introduction of concepts of open space planning related to urban, suburban, new town and regional land use. An investigation of contemporary methods for open space preservation through private and municipal efforts will include inventory and analysis techniques for identifying community needs and physical resources. Fall, 1978.
Prerequisite: Permission of instructor.

655. Public Policy and the Urban Environment **(3)**
Three hours of seminar per week. This course investigates public policy decisions as they affect the physical and social patterns of the environment. Seminar discussions based on readings and case study investigation. Spring, 1979.
Prerequisite: Permission of the instructor.

697. Seminar—Topics and Issues of Physical Environment **(2)**
Current topics for discussion are selected in order to acquaint the entering graduate student with a generalized view of the issues of the physical environment. Fall, 1978.
Prerequisite: Permission of instructor.

699. Research Methods and Techniques **(3)**
Three hours of lecture per week. The course examines the design and development of research problems pertinent to landscape architecture and environmental planning. The course will concentrate on three major areas: (1) Areas of Potential Research, (2) Research Methods and Techniques and (3) Proposal Writing. A variety of approaches to research in human-environment interactions will be discussed and explored with reference to their relevance and applicability to graduate research. Spring, 1979.
Prerequisite: Permission of instructor.

711. Human Behavior and Environmental Form **(3)**
Consideration of the nature and dynamics of people's movements in space as clues to their relationship with their environments. An examination of the basic social and behavioral concepts that relate to the human use of the urban environment. Concepts such as behavior patterns, territoriality, cognitive mapping, urban images, preference, neighborhood and community will be explored within the framework of "social space." The implications of such behavioral studies in the design of the environment will be considered.
Prerequisite: Permission of instructor. Fall and Spring, 1978-79.

720. Graduate Studio II **(4)**
Six hours of studio and two lecture/seminar hours per week. An examination of the significance of behavioral research to landscape architectural design. The interrelationship between the design process as a professional approach and the techniques employed in the behavioral sciences will be examined. Application of design process and behavioral science techniques to a variety of projects will be explored in order to develop solutions supportive of human behavior. Spring.
Prerequisite: LSA 620 or permission of instructor.

721. Graduate Studio III **(4)**
Six hours of studio and two lecture/seminar hours per week. An examination of the significance of natural sciences to design in landscape architecture. The interrelationship between landscape architectural design and current findings concerning the tolerances of the natural environment to alteration. Students are responsible for developing the organization, administration, and management of assigned projects. Fall.
Prerequisite: LSA 720 or permission of instructor.

731. Plant Materials **(3)**
Seminars, individual conferences, field trips, readings. Guided individual study in aspects of plant materials related to landscape architecture. Fall or Spring, 1978-79.
Prerequisite: LSA 730 or permission of instructor.

740. Landscape Architectural Construction **(3)**
Lectures, drafting. Detailed study of special landscape construction problems. Preparation of estimates, contracts and specifications. Fall, 1978.
Prerequisite: LSA 542.

752. Methods of Urban and Regional System Dynamics **(3)**
Lectures and workshop. The major concerns of this course are application of system dynamics; basic principles of system dynamics; and system dynamics modeling. This method is investigated as a useful tool in modeling many landscape architectural and planning problems. No prior computer experience is necessary. Fall, 1978.
Prerequisite: Permission of instructor.

757. Methods of Corridor Location **(3)**
Three hours of lecture per week. This course emphasizes study of corridor types, traditional economic determinism, and the emergence of environmental, aesthetic and social concerns. Landscape architectural methods for corridor location and evaluation are reviewed and compared. These methods include graphic overlays, an automated data bank, unified scoring systems, and multiple accounts. Students will engage a course project. Spring, 1979.
Prerequisite: Permission of instructor.

796. Special Topics in Landscape Architecture **(1-3)**
One to three hours of class meetings per week. Special topics of current interest to graduate students in landscape architecture and related fields. A detailed course subject description will be presented as a topic area is identified and developed. Fall and Spring, 1978-79.
Prerequisite: Permission of instructor.

797. Seminar **(2)**
Two hours per week. Discussion of current topics, trends and research related to landscape architecture, planning, and management. Fall and Spring, 1978-79.
Prerequisite: Permission of instructor.

798. Research Problem
(Credit hours to be arranged according to nature of problem)
Special study of assigned problems relating to landscape architecture or planning, with emphasis on critical thinking. Fall and Spring, 1978-79.
Prerequisite: Permission of instructor.

799. Thesis Project Proposal Development **(1)**
One hour lecture/workshop per week. During this course, a student will prepare a proposal for a thesis/project in the MLA program. Fall, 1078.
Prerequisites: LSA 699 and permission of instructor.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

RESOURCE MANAGEMENT AND POLICY (RMP)

587. Environmental Law **(3)**

Three hours of lecture and discussion. Studies in Environmental Law designed for resource managers. Review of structure and processes of American legal system, constitutional framework of environmental law, The National Environmental Policy Act, legal framework for management of Federal lands, focus on legal aspects of common property resource management, land, water and air. Fall or Spring, 1978-79.

588. The Law of Natural Resource Administration **(3)**

Three hours of lecture and discussion. An introduction to the law concerning the procedures, powers and judicial review of public agencies responsible for the management of natural resources. Topics will include the extent of an agency's rule-making power and the rights of aggrieved parties to appeal from agency decisions. Spring, 1979.

Prerequisite: ERM 360 or equivalent course in public administration.

701. Resource Management Systems **(3)**

Three hours of lecture and seminar per week. Review of the structure and operation of the ecological and social environment within which resource managers operate. Major characteristics of the ecological utilization and control systems for forest and related natural resources are described and compared. Fall, 1978.

602. Resource Economics **(3)**

Three hours of lecture and discussion per week. Economic theory and analysis in resource management and use decisions. Study and application of economic models to land, water, forest, wildlife and recreational resources. Relationships and interactions of public and private sector in resource management. Fall, 1978.

603. Research Methods in Resource Management and Policy **(3)**

Three hours of lecture and discussion per week. Study of the elements of research methodology including statistics and their application to analyzing and resolving problems both basic and applied in the managerial and policy sciences. Fall, 1978.

606. Management Principles and Processes **(3)**

Three hours of lecture and group discussion. The central focus of this course is on decisionmaking, organization and information theories as they relate to the total management process. Spring, 1979.

Prerequisite: Basic understanding of management functions and processes as found in ERM 360.

629. Environmental Impact:Qrinciples and Strategies **(3)**

Three hours of lecture and discussion. Principles and theory of environmental impact and statements of impact as required by Federal law. Administrative procedures for review and evaluation. Procedural strategy and effective constitution of statements for various governmental levels. Means of obtaining sources of authoritative information. Fall and Spring, 1978-79.

642. Water Quality Management **(3)**

Three hours of lecture and seminar per week. The review of the ethical, historical, legal and technical basis for water quality management. Investigation of public policy on the international, Federal, state and local levels and the administrative methods and programs used to implement policy. Fall, 1978.

643. Urban Water Management **(3)**

Three hours of lecture and seminar per week. A review of the role of urban water management in water resources management. The problems and issues of providing water utilities services of water supply, drainage and waste water facilities including such considerations as planning, financing, local government, intergovernmental relations, state and Federal role, water institutions and applicable law. Spring, 1979.

662. Land Use Economics **(3)**
Three hours of lecture/discussion per week. Study of the theory and methods of land use economics and the application of economic analysis to open space and regional planning. Emphasis is on understanding basic concepts, developing of operational methods and data sources. Case studies, outside readings, and guest speakers are utilized. Fall, 1978.
Prerequisites: One course in macroeconomics and one in microeconomics and permission of instructor.

664. Soil and Water Conservation **(3)**
Three hours of lecture and discussion. An integrated examination of the many aspects of the field of water and related land resource conservation in the United States. Topics include the evaluation and present status of planning, organizational, economic and legal constraints on the development of policies and programs of the Federal agencies, state and local government and private units. Fall, 1978.
Prerequisite: Permission of instructor.

670. Economics of Nonmarket Goods **(3)**
Group discussion, lectures, guided readings, case studies and student projects on the economic aspects of watershed management, fish and wildlife management, and outdoor recreation. Major topics include theories of valuation and application to nonmarket goods, cost analysis for nonmarket goods, and measurement of regional impacts. Spring, 1979.
Prerequisites: ERM 206 or equivalent, knowledge of basic statistical analysis, and 6 hours or more of resource management coursework.

672. Open Space Planning (Recreation) **(3)**
Three hours of lecture/discussion per week. Study of methods and techniques applicable to open space planning in nonurban areas. Survey of literature and current research. Open space standards, classification systems and inventory methods. Development of plans for large scale recreation areas, and inclusion of recreation into regional plans. The interrelationship and conflicts between resource utilization/development and recreation/aesthetics reviewed through case studies. Fall, 1978.
Prerequisites: One course in outdoor recreation, one course in planning, and permission of instructor.

675. Social Psychology of Leisure Behavior **(3)**
Three hours of lecture and discussion. Introduction to theory and research findings dealing with the sociological and psychological aspects of leisure behavior: field work and lectures demonstrate applications, particularly in outdoor recreation. Spring, 1979.

751. World Forestry **(3)**
Three hours of lecture and discussion. World forest distribution and types; regional production and consumption of forest products; international trade in timber and related products; the role of forest resources in development; and special topics; tropical forestry, comparative forest policies and programs, forestry education, the problems of developing countries, international cooperation in forestry development, the role of the United States in world forestry, etc. Fall or Spring, 1978-79.

753. Resources Policy **(3)**
Three hours of lecture and seminar. Evaluation of basic environmental and resource issues and their evolvement in public and institutional policies. Exploration of alternative resource goals, policies, and program approaches and their implications. Analysis of processes for policy delineation and modification. Spring, 1979.

754. Advanced Forest Administration **(3)**
Critical appraisal of existing public, semipublic and private forestry agencies in the United States, and the comparative study of major administrative organizations and practices. Occasional inspection trips to forestry headquarters and field units and discussion of internal administrative problems with forest officers. Fall or Spring, 1978-79.
Prerequisite: ERM 360 or equivalent.

797. Seminar **(1)**
Group discussion and individual conference concerning current topics, trends and research in management. Fall and Spring, 1978-79.

798. Research Problems in Resources Management and Policy
(Credit hours arranged according to nature of problem)
Special investigation and analysis of resources management problems where integrative relationships of several subject aspects of forestry are a major consideration. Fall and Spring, 1978-79.

899. Master's Thesis Research **(Credit hours to be arranged)**
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

999. Doctoral Thesis Research **(Credit hours to be arranged)**
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

SCHOOL OF CONTINUING EDUCATION (SCE)

510. Creative Problem Solving Seminar **(3)**
Three hours of lecture and discussion per week. A course designed to extend the students understanding and application of creative problem solving processes. One requirement will be to select and carry out an application of the techniques to a particular problem, with consultation and guidance from the instructor. Critique and survey of the literature on creativity, in-depth analysis of the synectics process and various procedures which have been developed for nurturing creative behavior comprise the essence of the program. Fall, 1978.
Prerequisite: Undergraduate degree or permission of instructor.
Note: also listed as EIN 510.

530. (FEN) Pest Identification, Biology and Management **(3)**
A study of the life history and management practices for pests common to the home, landscape and recreational areas. Suggested for pest control personnel and teachers of primary and secondary science areas. Not open to College of Environmental Science and Forestry students. Summer.
Prerequisite: One course in biology.

576. Special Topics Course: Environmental Education Processes and Strategies **(3)**
Lectures, discussions, field problems and structured outdoor laboratory assignments in environmental education processes and strategies for professional educators in elementary and secondary schools who are part-time, nonmatriculated at ESF. Summer.
Prerequisite: Consent of instructor. Not acceptable for credit in graduate programs of the School of Environmental and Resource Management.

596. Special Topics in Resource Management **(1-3)**
Lectures, field exercises, guided readings and discussions, in a short course format. The study of recent developments and applications in resource management. Illustrative topics include management of forest stands, resource economics, land planning or recreation planning and site development. Summer. Not acceptable for credit in graduate programs of the School of Environmental and Resource Management.
Prerequisite: Permission of instructor.

SILVICULTURE (SIL)

520. Application of Ecology **(3)**
Two hours lecture and discussion and one to three hours seminar, workshop, or field trip per week. Exploration of use and implications of ecological concepts for practices modifying terrestrial ecosystems for human benefit. Discussion of ecological writings in relation to applied problems; workshops, field trips and student presentations exploring ecological implications of specific situations. Course designed for interdisciplinary participation. Spring, 1979.
Prerequisite: An ecology course or permission of instructor.

553. Energy Exchange at the Earth's Surface **(3)**
Two hours of lecture and 3 hours of laboratory. A comprehensive study of the physical processes taking place in the lowest layer of the atmosphere. Primary emphasis on the turbulent transfer of heat, momentum and water vapor and the expression of these fluxes in the microclimate. Spring, 1979.
Prerequisites: ERM 452, physics and calculus.

625. Productivity of Forest Stands **(3)**
Examination of forest tree and stand production variables as related to silvicultural manipulation. Analysis of stand response, such as rate of growth, stem form, product quality, tree quality and value. Preparation of stand treatment schedules. Spring, 1979.
Prerequisite: Permission of instructor.

635. Forest Soils and Their Analyses **(3)**
One hour of lecture, 1 hour of recitation, 4 hours of field and laboratory study of forest soils, emphasizing plant-soil relationships. Stress on quantification of plant-soil diagnostic techniques and their interpretation. Fall, 1979.
Prerequisites: ERM 446; background in physical and biological sciences recommended.

640. Advanced Wildland Hydrology **(3)**
Lecture, discussion and laboratory sessions in advanced problems of forest and range hydrology, watershed management methods and techniques and evaluation of new methods of hydrologic data collection and analysis. Fall, 1978.
Prerequisite: ERM 440 or FEG 340.

641. Watershed Analysis **(3)**
One hour of lecture and 6 hours of laboratory each week. Lecture and field experience in watershed characterization, inventory, and analysis in terms of land management problems. Fall, 1978.
Prerequisites: ERM 440 and permission of instructor.

642. Snow Hydrology **(3)**
Three 1-hour lectures per week and two 3-day field trips. Physical characteristics of snow and the energy relations important in its accumulation and dissipation. Problems of measurement and prediction of runoff and melt. Potentials for management. Spring, 1979.
Prerequisite: ERM 440 or FEG 340.

677. Advanced Forest Tree Improvement **(3)**
Two hours of lecture and discussion and 3 hours of laboratory. A study of advanced principles and techniques for genetic improvement of forest trees. Special emphasis is placed on selection and breeding for growth rates, wood quality and insect and disease resistance. Problems of tree hybridization, racial variations, sexual reproduction, and quantitative genetics in forest trees. Laboratory training in cytology and cytogenetics, pollen germination, vegetative propagation and other problems. Independent research problems will be undertaken by the student. Fall or Spring, 1978-79.
Prerequisites: FBL 470 and 471, ERM 455.

730. Research Methods in Silviculture **(3)**
Three hours of lecture or discussion. Research concepts and methodology with particular application to silviculture and its related sciences. More appropriate to beginning students or before taking thesis work. Fall, 1978.
Prerequisite: Permission of instructor.

735. Forest Soil Fertility (Applied Studies) **(2-4)**
Two hours of lecture and 1 hour of discussion. Up to 6 hours of laboratory depending on number of credit hours. Influence of soil fertility on development and growth of seedlings and trees, and techniques involved to determine this influence. Chemical and biological analysis to determine levels of soil fertility. Nutrient element deficiencies and their correction by soil

amendments and fertilizers. Term projects by the student will be undertaken. Spring, 1979.
Prerequisites: CHE 332 and 333, FBO 530, ERM 446 and SIL 635, or equivalent.

737. Forest Soil Physics (4)
Three hours of lecture and discussion and 3 hours of laboratory. Presentation of principles of soil physics including water flow, storage and availability, soil permeability, heat transfer, and their consideration as root environmental factors. Analytical procedures are introduced and evaluated. Applications of soil physics to silvics, soil fertility, watershed management and hydrology, soil biology and land-use. Spring. (Odd years), 1979.
Prerequisites: ERM 345, 446, or their equivalents. Physical chemistry and integral calculus strongly recommended.

777. Quantitative Genetics in Forest Tree Improvement (3)
Two-hour lecture and discussion and 3 hours laboratory. Development of statistical models for determining heritability in forest trees. Breeding models and computer analysis application in forest genetics. Fall or Spring, 1978-79.

796. Special Topics in Silviculture (1-3)
Lectures, seminars, and discussion. Advanced topics in silviculture. Check schedules of classes for details of subject matter. Fall and/or Spring, 1978, as appropriate.

797. Graduate Silviculture Seminar (1)
Three-hour class discussion per week. Assigned reports and discussion of silvicultural topics. Fall and Spring, 1978-79.

798. Research Problems in Silviculture
(Credit hours arranged according to nature of problem)
Hours to be arranged. Fall and Spring, 1978-79.

899. Master's Thesis Research (Credit hours to be arranged)
Research and independent study for the master's degree and thesis. Fall and Spring, 1978-79.

999. Doctoral Thesis Research (Credit Hours to be Arranged)
Research and independent study for the doctoral degree and dissertation. Fall and Spring, 1978-79.

State University of New York

State University's 64 geographically dispersed campuses bring educational opportunity within commuting distance of virtually all New York citizens and comprise the nation's largest, centrally managed system of public higher education.

When founded in 1948, the University consolidated 29 State-operated, but unaffiliated, institutions. In response to need, the University has grown to a point where its impact is felt educationally, culturally and economically the length and breadth of the State.

More than 340,000 students are pursuing traditional study in classrooms or are working at home, at their own pace, through such innovative institutions as Empire State College, whose students follow individualized and often nontraditional paths to a degree. Of the total enrollment, more than 100,000 students are 24 years or older, reflecting State University's services to specific constituencies, such as refresher courses for the professional community, continuing educational opportunities for returning servicemen, and personal enrichment for the more mature persons.

State University's research contributions are helping to solve some of modern society's most urgent problems. It was a State University scientist who first warned the world of potentially harmful mercury deposits in canned fish, and another who made the connection between automobile and industrial smoke combining to cause changes in weather patterns. Other University researchers continue important studies in such wide-ranging areas as immunology, marine biology, sickle-cell anemia, and organ transplantation.

More than 1,000 Public Service activities are currently being pursued on State University campuses. Examples of these efforts include: special training courses for local government personnel, State civil service personnel, and the unemployed; participation by campus personnel in joint community planning or project work, and campus-community arrangements for community use of campus facilities.

A distinguished faculty includes nationally or internationally recognized figures in all the major disciplines. Their efforts are recognized each year in the form of such prestigious awards as Fulbright-Hayes, Guggenheim and Danforth Fellowships.

The University offers a wide diversity of what are considered the more conventional career fields, such as engineering, medicine, literature, dairy farming, medical technology, accounting, social work, forestry and automotive technology. Additionally, its responsiveness to progress in all areas of learning and to tomorrow's developing societal needs has resulted in concentrations which include pollution, urban studies, computer science, immunology, preservation of national resources, and microbiology.

SUNY programs for the educationally and economically disadvantaged have become models for delivering better learning opportunities to a once-forgotten segment of society. Educational Opportunity Centers offer high school equivalency and college preparatory courses to provide young people and adults with the opportunity to begin college or to learn marketable skills. In addition, campus based Educational Opportunity Programs provide counseling, developmental education and financial aid to disadvantaged students in traditional degree programs on most SUNY campuses.

Overall, at its EOC's, two-year colleges, four-year campuses and university and medical centers, the University offers 3,600 academic programs. Degree opportunities range from two-year associate programs to doctoral studies offered at 12 senior campuses.

The 30 two-year community colleges operating under the program of State University play a unique role in the expansion of educational opportunity, by:

Providing local industry with trained technicians in a wide variety of occupational curricula;

Providing transfer options to students who wish to go on and earn advanced degrees, and;

Providing the community with yet another source for technical and professional upgrading as well as personal enrichment.

During its brief history, State University has graduated more than 600,000 alumni, the majority of whom are pursuing their careers in communities across the State.

State University is governed by a Board of Trustees, appointed by the Governor, which directly determines the policies to be followed by the 34 State-supported campuses. Community colleges have their own local boards of trustees whose relationship to the SUNY board is defined by law. The state contributes one-third to 40 percent of their operating cost and one-half of their capital costs.

The State University motto is: "To Learn—To Search—To Serve."

STATE UNIVERSITY OF NEW YORK

UNIVERSITY CENTERS

State University at Albany
State University at Binghamton
State University at Buffalo
State University at Stony Brook

COLLEGES OF ARTS AND SCIENCES

College at Brockport
College at Buffalo
College at Cortland
Empire State College
College at Fredonia
College at Geneseo
College at New Paltz
College at Old Westbury
College at Oneonta
College at Oswego
College at Plattsburgh
College at Potsdam
College at Purchase

COLLEGES AND CENTERS FOR THE HEALTH SCIENCES

Health Sciences Center at Buffalo University Center
Health Sciences Center at Stony Brook University Center
Downstate Medical Center at Brooklyn
Upstate Medical Center at Syracuse
College of Optometry at New York City
College of Veterinary Medicine at Cornell University*

AGRICULTURAL AND TECHNICAL COLLEGES

College at Alfred
College at Canton
College at Cobleskill
College at Delhi
College at Farmingdale
College at Morrisville

SPECIALIZED COLLEGES

College of Agriculture and Life Sciences at Cornell University*
College of Ceramics at Alfred University*
College of Environmental Science and Forestry at Syracuse
College of Human Ecology at Cornell University*
College of Technology at Utica/Rome
Fashion Institute of Technology at New York City**
Maritime College at Fort Schuyler
School of Industrial and Labor Relations at Cornell University*

COMMUNITY COLLEGES

(Locally-sponsored, two-year colleges under the program of State University)

Adirondack Community College at Glens Falls
Broome Community College at Binghamton
Cayuga County Community College at Auburn
Clinton Community College at Plattsburgh
Columbia-Greene Community College at Hudson
Community College of the Finger Lakes at Canandaigua
Corning Community College at Corning
Dutchess Community College at Poughkeepsie
Erie Community College at Buffalo
Fulton-Montgomery Community College at Johnstown
Genesee Community College at Batavia
Herkimer County Community College at Herkimer
Hudson Valley Community College at Troy
Jamestown Community College at Jamestown
Jefferson Community College at Watertown
Mohawk Valley Community College at Utica
Monroe Community College at Rochester
Nassau Community College at Garden City
Niagara County Community College at Sanborn
North Country Community College at Saranac Lake
Onondaga Community College at Syracuse
Orange County Community College at Middletown
Rockland Community College at Suffern
Schenectady County Community College at Schenectady
Suffolk County Community College at Selden
Sullivan County Community College at South Fallsburg
Tompkins Cortland Community College at Dryden
Ulster County Community College at Stone Ridge
Westchester Community College at Valhalla

*These operate as "contract colleges" on the campuses of private universities.
**While offering a limited number of baccalaureate degree programs, in addition to the associate degree, FIT is financed and administered in the manner provided for Community Colleges.

College of Environmental Science and Forestry

COLLEGE ADMINISTRATION

President	EDWARD E. PALMER
Assistant to the President	JAMES C. JOSEPH
Assistant to the President for Community Relations	ROLLA W. COCHRAN
Vice President for Program Affairs	RICHARD E. PENTONEY
Assistant Vice President for Research Programs	DONALD F. BEHREND
Assistant Vice President for Academic Programs	ROBERT H. FREY
Coordinator of Sponsored Programs	J. DONALD MABIE
Executive Director, Institute of Environmental Program Affairs (IEPA)	DONALD F. BEHREND
Coordinator of Demonstration and Information, IEPA	ROLLA W. COCHRAN
Coordinator of Research, IEPA	RAYMOND L. MARLER
Vice President for Student Affairs	HARRISON H. PAYNE
Director of Admissions	ROBERT L. FRIEDMAN
Financial Aids Coordinator	JOHN R. REEVES
Registrar	ROBERT S. NORTH
Adjunct Foreign Student Counselor	VIRGINIA T. TORELLI
Vice President for Administration and Services	DAVID G. ANDERSON
Assistant to the Vice President	MICHAEL C. McCLOSKEY
Director of Business and Fiscal Affairs	HARRY J. CORR
Librarian	DONALD F. WEBSTER
Director of Educational Communications (Acting)	BERNARD T. HOLTMAN
Director of Computer Services	CHARLES N. LEE
Director of Personnel	STEPHEN H. MONTGOMERY
Director of Physical Plant	BRUCE E. REICHEL
Coordinator of Facilities	CHARLES N. LaFORTY
Director of Campus Safety and Security	BRIAN M. SPEER
Associate for Institutional Research	RHONDDA K. CASSETTA
Director of Analytical and Technical Services	JOHN A. MEYER
Affirmative Action Officer	ALTON W. ZANDERS
Dean, School of Biology, Chemistry and Ecology	STUART W. TANENBAUM
Dean, School of Continuing Education	JOHN M. YAVORSKY
Dean, School of Environmental and Resource Engineering	WILFRED A. CÔTÉ, JR.
Dean, School Environmental and Resource Management	CHARLES C. LARSON
Dean, School of Landscape Architecture	ROBERT G. REIMANN
Director, School of Forest Technology	JAMES E. COUFAL
Director, Graduate Program in Environmental Science	ROBERT D. HENNIGAN
Director, Adirondack Ecological Center	WILLIAM C. TIERSON
Director, Applied Forestry Research Institute	RAYMOND L. MARLER
Director, Empire State Paper Research Institute	BENGT LEOPOLD
Director, State University Polymer Research Center	MICHAEL M. SZWARC
Director, Ultrastructure Studies Center	WILFRED A. CÔTÉ, JR.
Director, Tropical Timber Information Center	ROBERT W. DAVIDSON
Director, Cellulose Research Institute	TORE E. TIMELL
Project Leader, U.S. Forest Service Cooperative Research Unit	ROWAN A. ROWNTREE

COLLEGE FACULTY AND PROFESSIONAL STAFF

This listing represents an official record of the State University of New York College of Environmental Science and Forestry faculty and professional staff for 1978. It is designed for use in 1978-79.

The date in parentheses after each name denotes the first year of service, two or more dates, the term of service. An asterisk (*) indicates graduate faculty.

LAWRENCE P. ABRAHAMSON (1977), *Senior Research Associate*, Applied Forestry Research Institute; B.S., Michigan Technical University, 1964; M.S., University of Wisconsin, 1967; Ph.D., University of Wisconsin, 1969.

MAURICE M. ALEXANDER (1949)*, *Professor*, Department of Environmental and Forest Biology; B.S., State University of New York College of Forestry, 1940; M.S., University of Connecticut, 1942; Ph.D., State University of New York College of Forestry, 1950

DOUGLAS C. ALLEN (1968)*, *Associate Professor*, Department of Environmental and Forest Biology; B.S., University of Maine, 1962; M.S., 1965; Ph.D., University of Michigan, 1968

IRA H. AMES (1972), *Adjunct Associate Professor*, Department of Environmental and Forest Biology; B.A., Brooklyn College, 1959; M.S., New York University, 1962; Ph.D., 1966

DAVID G. ANDERSON (1959), *Vice President for Administration and Services; Associate Professor;* A.A.S., State University of New York College of Forestry (Ranger School), 1950; B.S., State University of New York College of Forestry, 1953; M.S., University of Utah, 1958; M.P.A., Syracuse University, 1972.

ROBERT E. ANTHONY (1953), *Technical Specialist*, Department of Environmental and Forest Biology; A.A.S., State University of New York Agricultural and Technical College at Morrisville, 1952

GEORGE R. ARMSTRONG (1950)*, *Professor*, Department of Managerial Science and Policy; B.S., State University of New York College of Forestry, 1949; M.S., 1959; Ph.D., 1965

ROBERT W. ARSENEAU (1972), *Programmer/Analyst*, Computer Center; A.A.S., Mohawk Valley Community College, 1967

JAMES P. BAMBACHT (1967)*, *Associate Professor*, Department of Paper Science and Engineering; A.B., Kalamazoo College, 1954; M.S., The Institute of Paper Chemistry, 1956; Ph.D., State University of New York College of Environmental Science and Forestry, 1973

C. ELLISON BECK (1970), *Technical Specialist*, Analytical and Technical Services, Office of the Vice President for Administration and Services

DONALD F. BEHREND (1960-67) (1968)*, *Assistant Vice President for Research Programs; Executive Director of the Institute of Environmental Program Affairs*; *Senior Research Associate*; B.S., University of Connecticut, 1958; M.S., 1960; Ph.D., State University of New York College of Forestry, 1966

JOHN D. BENNETT (1960)*, *Associate Professor*, Department of Managerial Science and Policy; B.A., Ohio Wesleyan University, 1954; Ph.D., Syracuse University, 1968; *Chancellor's Award for Excellence in Teaching* (1973)

CAMILLO BENZO (1975), *Adjunct Associate Professor*, Department of Environmental and Forest Biology; B.A., Utica College of Syracuse University, 1964; Ph.D., University of Pennsylvania, 1969

JOHN V. BERGLUND (1965)*, *Professor and Chairman*, Department of Silviculture and Forest Influences; B.S., Pennsylvania State University, 1962; M.S., 1964; Ph.D., State University of New York College of Forestry, 1968

WILLIAM H. BETTINGER (1972), *Technical Specialist*, Analytical and Technical Services, Office of the Vice President for Administration and Services

DONALD H. BICKELHAUPT (1969), *Technical Assistant*, Department of Silviculture and Forest Influences; B.S., State University of New York College of Forestry, 1969

PETER E. BLACK (1965)*, *Professor*, Department of Silviculture and Forest Influences; B.S., University of Michigan, 1956; M.F., 1958; Ph.D., Colorado State University, 1961; *Executive Chairman of the Faculty* (1974-76) (1976-78)

WILLIAM R. BORGSTEDE (1971), *Technical Assistant*, Department of Environmental and Forest Biology; A.A.S., Minor Institute, 1966; A.A.S., State University of New York College at Delhi, 1970; B.S., State University of New York College of Environmental Science and Forestry, 1975

JEROME BREZNER (1961)*, *Professor*, Department of Environmental and Forest Biology; A.B., University of Rochester, 1952; A.M., University of Missouri, 1956; Ph.D., 1959

ROBERT H. BROCK, JR. (1967)*, *Professor*, Department of Forest Engineering; B.S., State University of New York College of Forestry, 1958; M.S., 1959; Ph.D., Cornell University, 1971

RANIER H. BROCKE (1969)*, *Senior Research Associate*, Adirondack Ecological Center; B.S., Michigan State University, 1955; M.S., 1957; Ph.D., 1970

ALTON F. BROWN (1963) *Technical Specialist*, Empire State Paper Research Institute

THOMAS E. BROWN (1977), *Adjunct Assistant Professor*, Department of Environmental and Forest Biology; B.S., Niagara University, 1957

KENNETH F. BURNS (1970), *Technical Assistant*, Applied Forestry Research Institute; A.A.S., Paul Smith's College, 1969

HARRY W. BURRY (1962), *Extension Specialist*, Applied Forestry Research Institute; *Associate Professor*; B.S., State University of New York College of Forestry, 1941; M.F., 1964

PAUL M. CALUWE (1969)*, *Senior Research Associate*, Department of Chemistry; M.S., University of Louvain, 1964; Ph.D., 1967

ROBERT CAMERON (1974), *Research Assistant*, Adirondack Ecological Center; State University of New York College of Environmental Science and Forestry (Ranger School), 1973

WILBUR H. CAMPBELL (1975), *Assistant Professor*, Department of Chemistry; A.A., Santa Ana College, 1965; B.A., Pomona College, 1967; Ph.D., University of Wisconsin, 1972

HUGH O. CANHAM (1966)*, *Associate Professor*, Department of Managerial Science and Policy; B.S., State University of New York College of Forestry, 1960; M.S., 1962; Ph.D., 1971

DIANNE M. CAPRITTA (1967), *Associate Librarian*, F. Franklin Moon Library; B.S., University of Illinois, 1965; M.S.L.S., Syracuse University, 1967

RHONDDA K. CASSETTA (1967), *Associate for Institutional Research*, Office of the Vice President for Administration and Services; A.B., Elmira College, 1933

ROBERT E. CHAMBERS (1967)*, *Associate Professor*, Department of Environmental and Forest Biology; B.S., Pennsylvania State University, 1954; M.S., 1956; Ph.D., Ohio State University, 1972

WILLIAM M. CHRISTIAN (1974), *Technical Assistant*, Department of Security and Safety

NEILS B. CHRISTIANSEN (1960)*, *Associate Professor*, Department of Managerial Science and Policy; B.S., University of Idaho, 1957; M.S., State University of New York College of Forestry, 1959; Ph.D., 1966

ROLLA W. COCHRAN (1964), *Assistant to the President for Community Relations*; Office of the President; *Associate Professor*; Coordinator of Demonstration and Information, Institute of Environmental Affairs; B.A., Denison University, 1949; M.S., Ohio State University, 1951

JAMES M. COLMAN (1973), *Assistant Director of Admissions*, Office of the Vice President for Student Affairs; B.A., Villanova University, 1967; M.A., Lateran University, 1968

HARRY J. CORR (1967), *Director of Business and Fiscal Affairs*, Office of the Vice President for Administration and Services; B.S. Siena College, 1957

WILFRED A. COTE, JR. (1950)*, *Professor and Dean*, School of Environmental and Resource Engineering; *Director*, Nelson Cortlandt Brown Center for Ultrastructure Studies; B.S., University of Maine, 1949; M.F., Duke University, 1950; Ph.D., State University of New York College of Forestry, 1958

JAMES E. COUFAL (1965), *Director and Associate Professor*, School of Forest Technology; State University of New York College of Forestry (Ranger School), 1957; B.S., State University of New York College of Forestry, 1960; M.S., 1962; Ed.S., State University of New York at Albany, 1976

PHILLIP J. CRAUL (1968)*, *Associate Professor*, Department of Silviculture and Forest Influences; B.S.F., Pennsylvania State University, 1954; M.S., 1960; Ph.D., 1964

JAMES O. CREVELLING (1970), *Technical Assistant*, Department of Environmental and Forest Biology; A.A.S., Paul Smith's College, 1965; M.S., University of Massachusetts, 1967

CLAY M. CROSBY (1964), *Research Assistant*, Empire State Paper Research Institute; B.S., State University of New York College of Forestry, 1964; M.S., 1970

SHEILA M. CROWLEY (1977), *Assistant for Institutional Research*, Office of the Vice President for Administration and Services; A.B., Albertus Magnus College, 1967

TIBERIUS CUNIA (1968) *Professor*, Department of Managerial Science and Policy; Forest Engineer, Ecole Nat. des Eaux et Forets, 1951; M.S., McGill University, 1957

GEORGE W. CURRY (1966)*, *Professor*, School of Landscape Architecture; B.A., Michigan State University, 1962; B.S., 1965; M.L.A., University of Illinois, 1969

BENJAMIN V. DALL (1975)*, *Professor and Chairman*, Department of Managerial Science and Policy; B.S., Yale University, 1955; M.F., 1956; J.D., University of Virginia, 1959; Ph.D., Pennsylvania State University, 1972

ROBERT W. DAVIDSON (1957)*, *Professor and Chairman*, Department of Wood Products Engineering; *Director*, Tropical Timber Information Center; B.S., Montana State University, 1948; M.S., State University of New York College of Forestry, 1956; Ph.D., 1960

ARNOLD C. DAY (1969), *Technical Specialist*, Nelson Cortlandt Brown Center for Ultrastructure Studies

SALVACION De La PAZ (1973), *Associate Librarian*, F. Franklin Moon Library; B.S.L.S., University of the Philippines, 1956; M.S.L.S., Simmons College, 1962

CARLTON W. DENCE (1951)*, *Senior Research Associate*, Empire State Paper Research Institute; *Professor*, B.S., Syracuse University, 1947; M.S., State University of New York College of Forestry, 1949; Ph.D., 1959

CARL H. DeZEEUW (1946)*, *Professor*, Department of Wood Products Engineering; A.B., Michigan State College, 1934; B.S., 1937; M.S., State University of New York College of Forestry, 1939; Ph.D., 1949

ARTHUR G. DILLON (1976), *Technical Assistant*, Department of Paper Science and Engineering; B.S., State University of New York College of Environmental Science and Forestry, 1974

DANIEL L. DINDAL (1966)*, *Professor*, Department of Environmental and Forest Biology; B.S., Ohio State University, 1958; M.A., 1961; Ph.D., 1966; *Chancellor's Award for Excellence in Teaching* (1974)

GEORGE F. EARLE (1952)*, *Professor*, School of Landscape Architecture; B.F.A., Syracuse University, 1937; M.F.A., Yale University, 1946

ANDREW L. EGGERS (1967), *Media Engineer*, Educational Communications Section, Office of the Vice President for Administration and Services

THOMAS ELIAS (1977), *Adjunct Associate Professor*, Department of Environmental and Forest Biology; B.A., Southern Illinois University, 1964; M.A., 1966; Ph.D., St. Louis University and the Missouri Botanical Garden, 1969.

ELIZABETH A. ELKINS (1973), *Associate Librarian*, F. Franklin Moon Library; B.A., Hartwick College, 1968; M.L.S., State University of New York at Geneseo, 1970

JOHN H. ENGELKEN (1959), *Assistant Professor; Forest Property Manager*, Tully Campus; B.S.F., Utah State University, 1950

ARTHUR R. ESCHNER (1961)*, *Professor*, Department of Silviculture and Forest Influences; B.S., State University of New York College of Forestry, 1950; M.S., Iowa State College, 1952; Ph.D., State University of New York College of Forestry, 1965

AMINUR EUSUFZAI (1977), *Technical Assistant*, Empire State Paper Research Institute; B.Sc. (Hons.), Decca University, 1957; M.Sc., Decca University, 1960; B.Sc. (Hons.), Beshawar University, 1962, M.S., West Virginia University, 1969.

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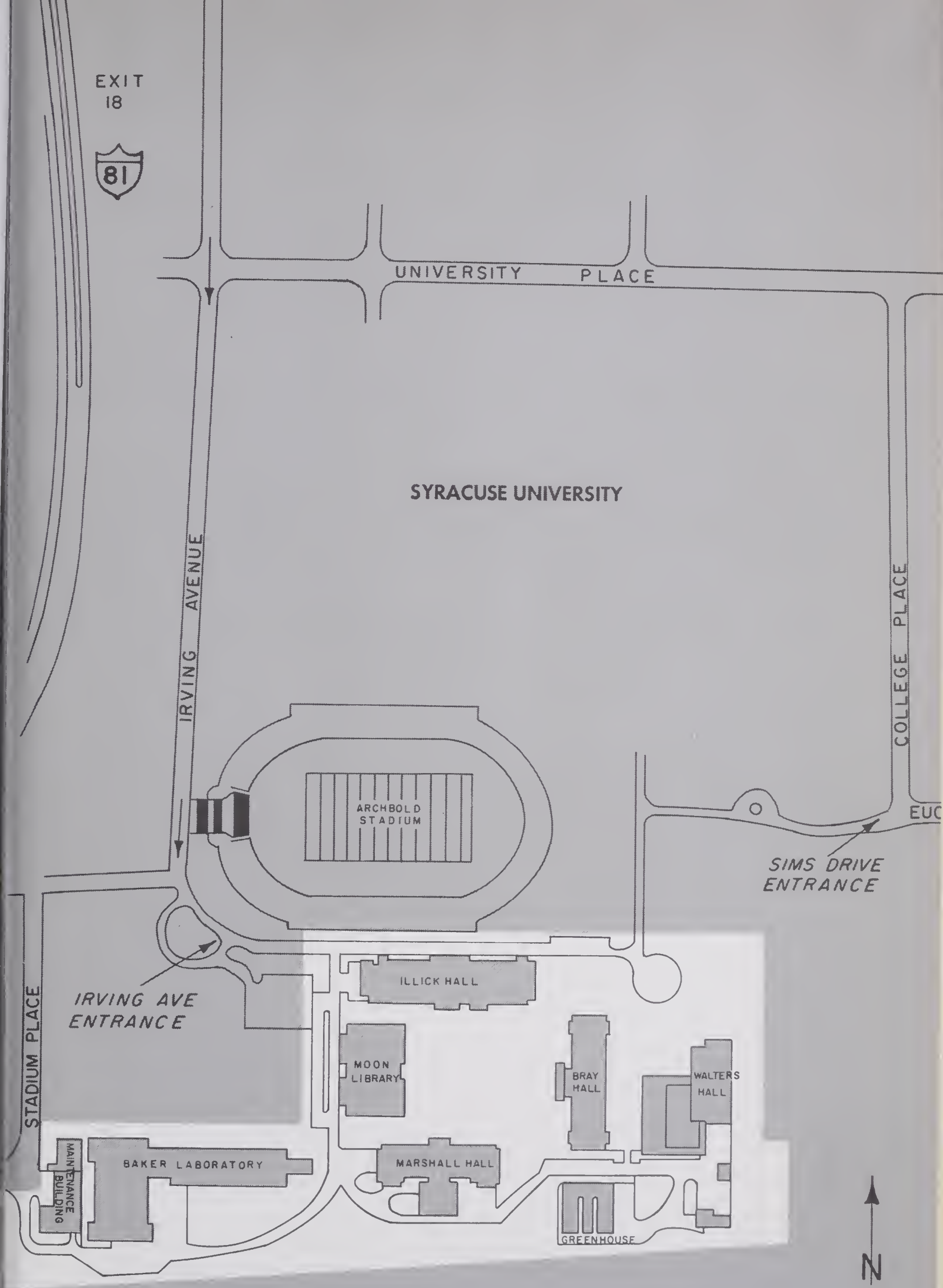
Index

Adirondack Ecological Center 18
Administration, College 95
Admission 27
-Requirements 27
-Advanced Tests 27
-Procedure 27
-International Students 28
AFRI 11
Applied Forestry Research Institute 11
Assistantships 33
Biology, Chemistry and Ecology, School of 35
Biology, Environmental and Forest 36
Board of Trustees
-ESF 94
-SUNY 91
Calendar, Academic 2
Campuses, Regional System of 15
Career Services 32
Chemical Ecology 42
Chemistry 41
College-Wide Program in Environmental Science 35, 57
Commencement Fee 29
Computer Center 17
Continuing Education 9, 84
Cooperative Research Unit, U.S. Forest Service 13
Correspondence Directory Inside Front Cover
Cornell University 65
Course Offerings 67
Cranberry Lake Campus 18
Degree Requirements 25
Degrees, Graduate 25
Ecology 38
Economics, Forestry 51
Educational Communications Unit 17
Ellis International Laboratory 18
Empire State Paper Research Institute 12
Employment, Part-Time 34
Engineering, Forest 43
Engineering, Paper Science and ... 44
Engineering, Wood Products 46
Entomology 38
Environmental and Forest Biology 36
Environmental and Resource Engineering, School of 35, 43
Environmental and Resource Management, School of 35, 47
Environmental Assessment 60
Environmental Biochemistry and Physiology 42
Environmental Communications .. 52
Environmental Education/ Communication 59
Environmental Land Use Planning 60
Environmental Science 60
Exchange Programs 65
Expenses, Student 29
Experiment Station 18
Faculty, College 96
Faculty, Emeritus 108
Fellowships 33
Financial Assistance 33
Fish and Wildlife Biology 39

Forestry Economics 51
Forest Engineering 43
Forest Influences 56
Forest Management 50
Forest Pathology and Mycology ... 39
Forest Service, U.S. 13
Forest Soil Science 55
Forest Technology, School of 17
Genetic Field Station 18
Heiberg Memorial Forest 17
History and Traditions, College 5
Housing, Student 30
Huntington Wildlife Forest 18
Institute of Environmental
Program Affairs 11
Instruction 8
-Continuing Education 9
-Graduate 8, 23
-Professional 8
-Technical 8
Insurance, Health and Accident ... 30
Interdepartmental Areas of Study .. 42
International Students 28
Landscape Architecture,
School of 35, 61
Land Use Planning 51
Loans, Educational 34
Management 52
Managerial Science and Policy 47
Map and Locator, Campus 111
Mission, College 8
Moon Library, F. Franklin 16
Newcomb Campus 18
Pack Demonstration Forest, C.L. .. 18
Paper Science and Engineering 44
Pathology, Forest 39
Plant Science 39
Policy and Administration 50
Polymer Center, SUNY 12
Professional Staff 96
Public Service 13
Quantitative Methods 51
Recreation Management 50
Refunds 30
Research 10
Resource Management and
Policy 48
Silvics 54
Silviculture 52, 54
Silviculture and Forest
Influences, Department of 47
Soil Ecology 40
State University of New York 87
Syracuse Campus, ESF 15
Syracuse Metropolitan Area 21
Syracuse University 6
Tree Improvement 55
Tuition and Fees 29
Tuition Assistance Program 34
Tuition Waiver Scholarships 33
Tully Campus 17
Ultrastructure Studies
Laboratory, N.C. Brown 13
Urban Forestry Concentration 57
Wanakena Campus 17
Warrensburg Campus 17
Water Resources 59
Wood Products Engineering 46
Work-Study Program 34
World Forestry Concentration 56
Zoology 40

Campus Locator

Admissions	110 Bray
Affirmative Action	110 Bray
Alumni/Development	121 Bray
Analytical and Technical Services	139 Baker
Applied Forestry Research Institute	6 Moon
Assistant Vice President for Academic Programs	200 Bray
Assistant Vice President for Research	200 Bray
Audio-tutorial Center	16 Moon
Business and Fiscal Affairs	102 Bray
Career Services	107 Bray
Cellulose Research Institute	314 Baker
Community Relations	123 Bray
Computer Services	320 Baker
Counseling Services	107 Bray
Educational Communications	302 Illick
Empire State College	114 Walters
Empire State Paper Research Institute	317 Walters
Facilities	Maintenance Building
Film Library	9 Moon
Financial Aids	111 Bray
International Forestry	319 Bray
Institute of Environmental Program Affairs	200 Bray
Institutional Research	206 Bray
Library	101 Moon
Maintenance and Operations	Maintenance Building
Personnel	224 Bray
President	204 Bray
Publications	100 Bray
Registrar	113 Bray
School of Biology, Chemistry and Ecology	311 Baker
School of Continuing Education	231 Baker
School of Environmental and Resource Engineering	208 Walters
School of Environmental and Resource Management	319 Bray
School of Landscape Architecture	331 Marshall
Security and Safety	8 Bray
Student Council	18 Moon
SUNY Polymer Research Center	216 Baker
Ultrastructure Studies Center	417 Baker
U.S. Forest Service Cooperative Research Unit	106 Marshall
Veterans' Affairs	107 Bray
Vice President for Administration and Services	208 Bray
Vice President for Program Affairs	227 Bray
Vice President for Student Affairs	107 Bray
Wood Utilization Service, Applied Forestry Research Institute	13 Moon



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